Regional Fishery Survey and Development Project FI: DP/RAB/71/278/10

Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates

A report on the

DEMERSAL RESOURCES OF THE GULF AND GULF OF OMAN

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED NATIONS DEVELOPMENT PROGRAMME
Rome, 1981

TABLE OF CONTENTS

Page

PREFACE v

SUMMARY vii

REFERENCES ix

Part 1: DEMERSAL RESOURCES SURVEY CARRIED OUT BY THE PROJECT by K. Sivasubramaniam 1

1.1 Introduction 1
1.2 Survey Plan 2
1.3 Implementation of the Survey Plan 3
1.4 Methods of Data Analysis 5
1.5 Survey Results 7

1.5.1 Species Composition 7
1.5.2 Distribution of Catch Rates 8
1.5.3 Seasonal Variation in Distribution 20
1.5.4 Day-Night Variations 22
1.5.5 Biological Information 23
1.5.6 Biomass Estimates 25

Part 2: BIOLOGICAL INFORMATION COLLECTED DURING THE DEMERSAL RESOURCES SURVEY by K. Sivasubramaniam 57

2.1 Introduction 57
2.2 Sampling Procedure 57
2.3 Biological Information by Families and Species 57

2.3.1 Ariommidae (driftfishes) 57
2.3.2 Ariidae (catfishes) 58
2.3.3 Carangidae (horse mackerels, scads, jacks, etc.) 58
2.3.4 Chirocentridae (wolf herring) 60
2.3.5 Lethrinidae (emperors, scavengers) 60
2.3.6 Lutjanidae (snappers) 61
2.3.7 Mullidae (goatfishes) 61
2.3.8 Nemipteridae (threadfin breams) 62
2.3.9 Pomadasyidae (grunts, sweetlips) 62
2.3.10 Rachycentridae (cobias) 63
2.3.11 Serranidae (groupers) 63
2.3.12 Sparidae (seabreams) 64
2.3.13 Synodontidae (lizardfishes) 65

Part 3: REVIEW OF EXPLORATORY TRAWLING INVESTIGATIONS AND COMMERCIAL FISHING VENTURES IN THE GULFS by M. Yesaki 89

3.1 Gulf Between Iran and the Arabian Peninsula 89

Page

3.1.1 Fishing Vessel RASHGOO 89
3.1.2 Fishing Vessel NEW HOPE 89
3.1.3 Fishing Vessels TATSUTA MARU and SHINANO MARU 90
3.1.4 Various USSR Vessels SRTM's, RTM LESNOI and PPR VAN GOGH 92
3.1.5 Research Vessel UMITAKA MARU 94
3.1.6 Research Vessel EL HADITH 95
3.1.7 Fishing Vessel GAZELLE 95

3.2 Gulf of Oman and North Arabian Sea 98

3.2.1 Fishing Vessels KHASAB, BUKHA and DHALKOT 98

3.3 Comparison of Areas in the Gulf and Gulf of Oman 108

Part 4: DISCUSSION AND EVALUATION OF THE DEMERSAL RESOURCES by K. Sivasubramaniam 116

4.1 Production Estimates of Demersal Species 116
4.2 Fishing Areas and Gear 116
4.3 Catch Rates 119
4.4 Estimates of Potential Yield 120
4.5 General Evaluation 121

PREFACE

This report is the result of the collective efforts of the following project biologists and national counterparts who made field observations, data collection and participated in the analyses and preparation of this report.

A. Al Madhaji	January 1977 - July 1977	
L. Hartsuijker	November 1977 - June 1979	
W.J. Scheffers	July 1976 - December 1978	Project biologists
J. Vidal-Jünemann	July 1976 - June 1979	
P. Walczak	November 1977 - December 1978	
M. Yesaki	November 1976 - April 1979	
N.P. van Zalinge	May 1977 - July 1977	

J. Al Qaseer	Bahrain	National counterparts
S.A.A. Al Mahmeed (Fishery Statistics)	Bahrain	
D. Herdson (ODM)	Bahrain	
N. Assadisamani	Iran	
M. Manoucherian	Iran	
F. Mohammadian	Iran	
A. Muhammadpour	Iran	
A. Al Ghanim	Kuwait	
A. Ashkanani	Kuwait	
H. Haddad	Kuwait	
A. Haja	Kuwait	
M. Hassan	Kuwait	
A. Al Harithy	Oman	
K.S. Farsi	Oman	
K.S. Said	Oman	

J. Flowers (December 1975 - June 1978) and Ms F. Vezzosi (July 1978 - April 1979) - data processing experts based in FAO Headquarters, Rome, were in charge of preparing and executing the computer programme for the analyses of the survey results.

The survey programme was supervised by M. Yesaki (November 1976 - December 1977) and K. Sivasubramaniam (January 1978 - August 1979); L.K. Boerema and S.C. Venema (FAO Fishery Resources Officers) provided necessary advice and assistance in the analyses of the data and in the preparation of this report.

The demersal resources survey would not have been possible without the availability of the national research vessels AL BAHETH (Bahrain), LAVAN 03 (Iran), SABAH (Kuwait) and DARBAT (Oman). The cooperation of the national authorities in making every effort to overcome problems encountered with vessel availability, and to assist in any other way, is gratefully acknowledged.

The advice, assistance and cooperation rendered by the captains of the various research vessels were essential for reaching the objectives of the survey.

The masterfishermen participating in the demersal survey programme were:

T. Gestsson (November 1976 - September 1978)	SABAH, DARBAT, AL BAHETH and LAVAN 03
T. Hinriksson (August 1978 - May 1979)	AL BAHETH
L. Smith (November 1977 - May 1979)	LAVAN 03 and SABAH
M. Wakamatsu (September 1976 - December 1978)	DARBAT, SABAH and LAVAN 03
T. Watson (June 1978 - April 1979)	DARBAT

They played an important role in executing this programme and were responsible for the fishing operations according to standards laid down, for the maintenance and repair of fishing gear and related equipment and for providing any information relevant to the survey.

This report consists of four parts. Part 1 contains a description of the resource survey for demersal fish carried out by the project, and Part 2 contains the biological data collected during that survey. In Part 3, prepared by M. Yesaki, a review is given of data on trawl fisheries collected by research vessels and commercial operations. In Part 4, the results of the survey and the separate studies are discussed and summarized in the light of potential yields, development possibilities and further research required.

SUMMARY

The demersal resources survey was carried out during the period November 1976 to January 1979, by four vessels contributed by Bahrain, Iran, Kuwait and Oman. For this survey, the total project area was divided into three areas and five depth strata, which were subdivided into 38 substrata. In each substratum a number of fishing stations were established in proportion to its surface area, following a stratified random sampling scheme.

In the execution of the first phase of the survey, 695 stations were sampled, whereas another 512 stations were found to be in areas which were inaccessible for one reason or another, or to present a high risk of damage to the standard trawl gear. Stations in the rough grounds were sampled later, during the second phase of the survey, which brought the total number of stations sampled up to 754.

Though a large number of families of fishes have been identified in the catches, only about 25 percent of these contributed significantly to the catch composition. There was a large variation in the species composition between substrata.

The results of the survey show that, in general, the fish density in the deeper part of the Gulf, over 50 m depth, was relatively low, giving average catches of 100-300 kg/h of all commercial species, except in the southeastern part of the Gulf where they reached over 400 kg/h. In general, the catch rates were highest in the 25-50 m depth zone, especially along the Iranian coast, where, on an average, over 600 kg/h were caught as against 300-400 kg/h on the Arabian side. In the shallow water zone of 10-25 m depth, the average catch rates ranged from 100-400 kg/h, with a higher mean catch rate of over 500 kg/h on the Iranian side.

In the Gulf of Oman the catch rates were generally somewhat higher than in the Gulf and the best catch rates were obtained in deeper waters.

In addition to these catches of commercial species, other species were caught, which have been presently classified as noncommercial in most of the countries in the area, but part of which may become marketable in the future. About 40 percent of the demersal species fell in this group. The greatest quantities of these noncommercial species were found along the Iranian coast.

Some of the most valuable species groups, such as Serranidae (groupers) and Lutjanidae (snappers), were found especially along the Arabian side of the project area. But even in the best area these groups had a low abundance, with catch rates of maximum 25 kg/h in the Gulf and 30 kg/h in the Gulf of Oman for groupers, and 60 kg/h for snappers. Detailed maps of the average catch rates by substratum for the total commercial species groups, noncommercial species groups and for several species groups are given in the report, illustrating the different distributions of the various species groups.

From the average catch rates, the area covered by the trawl per hour of fishing and the size of each substratum, estimates of the biomass of the various species groups in the project area were obtained. The report contains tables of the total biomass estimates and of the species composition in each substratum, from which biomass for each species or species groups and substratum or combinations of substrata can be calculated as required.

Good results on seasonal variations, migration and other biological factors could not be obtained due to circumstances affecting the operational schedule of the survey vessels. Diurnal variations in species distribution seemed to influence the catch rates differently in different substrata, with a tendency for higher catch rates to be realized in the daytime. However, this difference was mainly caused by the pelagic species entering the trawl catches.

The biomass of all commercially valuable demersal species in the whole project area was estimated as 600 000 t, of which 500 000 t were in the Gulf and 100 000 t in the Gulf of Oman. The total biomass of commercially valuable demersal fish in the depth range of 10-50 m along the Iranian side of the Gulf was estimaed at 89 000 t, in the northwestern part of the Gulf or the Shatt Al Arab area (substrata 1A2 and 1B2) 56 000 t, and on the Arabian side 200 000 t. The deeper part of the Gulf, between 50 and 100 m, was estimated to have a biomass of 147 000 t of commercially valuable demersal fish. In the Gulf of Oman, the biomass of about 100 000 t was more or less equally divided between the Iran and Oman sides.

Artisanal and large-scale fisheries were exploiting the demersal resources in the project area. In the absence of good catch statistics, on the basis of occasional sampling and available information, the present level of landings of demersal fish species was estimated to be in the region of about 48 000 t/a. The information from existing fisheries indicated very small seasonal variation in the catch rates of demersal fish, but seasonal changes in the composition of the catches were evident, particularly influenced by the highly seasonal variation in the components of the pelagic stocks entering the demersal fishery within the project area. Existing fisheries also covered a large part of the survey area, excluding the central deep part and hence seemed to exploit the main stocks in the project area.

The data on the biomass have been used to estimate the potential yield of the stocks of the commercial species of demersal fish in the area, taking into account that the present catches of these fish are estimated at about 58 000 t (of which 10 000 t are not landed). The maximum potential yield of the commercial species was estimated at about 142 500 t for the Gulf and 36 500 t for the Gulf of Oman. When the actual catches are substracted from these figures the available surplus is respectively 107 500 and 13 500 t.

The results obtained are only first estimates and based on various assumptions, and therefore monitoring surveys and systematic compilation of catch and effort statistics should be undertaken for future assessments of the status of stocks and for effective management measures.

REFERENCES

Abbes R. and H. Farrugio, Analysis of the traditional fishing activities in Bushehr and
1977 Bandar Abbas. Bull.Sci.Tech.Mar.Fish.Res.Inst.Iran, (13)

Afzal, M. and F. Jowhar Hayat, A study of fish consumption habits in Kuwait. Publ.Kuwait
1977 Inst.Sci.Res., (KISR/P-G-RP-7701)

Alkholi, A.B. and B. Soloviov, Fisheries of Kuwait. Kuwait, Ministry of Public Works,
1978 (in Arabic)

Al-Nasiri, S.K. and K.P. Sharma, The fishery potentialities of the Republic of Iraq.
1975 Vol. 4. J.Cent.Arab.Gulf Stud.,

Blegvad, H. and B. Løppenthin, Fishes of the Iranian Gulf. Dan.Sci.Invest.Iran, (3):247 p.
1944

FAO/UN, Report to the Government of Iran on the exploratory fishing survey in the Bandar
1957 Abbas region (1955/56). Based on the work of H. Fibiger and K. Frederiksen,
FAO Masterfishermen. Rep.FAO/ETAP, (646):36 p.

FAO, Report to the Government of Kuwait on the fisheries of Kuwait. Based on the work of
1970 A. Meschkat, FAO Fishery Consultant. Rome, FAO, Kuwait Funds-in-Trust,
FAO/KUW/TF 27:36 p.

FAO, Survey technique and strategy, Report of the Ad Hoc Working Group on survey technique
1976 and strategy. Rome and Doha, 15-26 September 1975. Rome, FAO.
FI:DP/RAB/71/278/1:45 p.

FAO, Stock assessment of shrimp in the Indian Ocean area. Report of the Ad hoc group of
1977a the IOFC special Working Party to consider the stocks in the area covered by
the Regional Fishery Survey and Development Project, REM/71/278 (Bahrain, Iran,
Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates). Doha, Qatar,
26-29 April, 1976. FAO Fish.Rep., (193):23 p.

FAO, Expected effects of regulatory measures in the shrimp trawl fishery. Rome, FAO,
1977b REM/71/278/CSC/3/7

FAO, Report of the Second Ad Hoc Working Group on survey technique and strategy. Doha,
1979 Qatar, 26 April-1 May 1978. Rome, FAO, FI:DP/RAB/71/278/5:21 p.

Flowers, J.M., A data processing and basic analysis system for demersal fisheries surveys.
1978 Rome, DP/RAB/71/278/4:152 p.

Gulland, J.A. (Comp.), Fish resources of the ocean. West Byfleet, Surrey, Fishing News
1971 (Books) Ltd., for FAO, 255 p.

Hartsuijker, L., M. Yesaki, A.M.A. Al Harthy and W.J. Scheffers, Fish market surveys in
1981 Kuwait, Oman and United Arab Emirates. Rome, FAO, FI:DP/RAB/71/278/17 (in
preparation)

Hull, L.E., Summary of the present state of knowledge concerning the Saudi Arabian Gulf
1978 shrimp fishery. Dammam, Saudi Arabian Fishery Development Project (mimeo)

Hull, L.E., Arabian Gulf demersal trawl resources report. Dammam, Saudi Arabian Fishery
1978 Development Project

Keddie, W.H., Fish and futility in Iranian development. J.Dev.Areas, 6:9-28
1971

Keyvan, A., M. Kamran and A. Nikuoyan, Present fisheries situation in Iran. IOFC/DEV/78/43.2
1978

Kristjonsson, H., A study of the artisanal fisheries of Qatar and recommendations for
1979 improvements. (mimeo)

Kristjonsson, H., Some aspects of small-scale fisheries in Bahrain. (mimeo)
1979

Kuronuma, K. (ed.), Arabian Gulf fishery-oceanography survey by the UMITAKA MARU, training-
1974 research vessel. Tokyo University of Fisheries with collaboration of Kuwait
Institute of Scientific Research. December 1968. Trans.Tokyo Univ.Fish.,
1:118 p.

Kuronuma, K. and Y. Abe, Fishes of Kuwait. Kuwait City, Kuwait Institute for Scientific
1972 Research:123 p., 20 plates in colour

Kuwait, United Fisheries of Kuwait, Fifth report of the board of directors for financial
1978 year ending 31 December 1977. Kuwait, United Fisheries of Kuwait

Kuwait, Ministry of Public Works, Fish production and export statistics for Kuwait. Kuwait,
1974-1976 Ministry of Public Works (mimeo)

Mackett, D.J., Manual of methods for fisheries resources survey and appraisal. Part 3.
1973 FAO Fish.Tech.Pap., (124):38 p.

Qatar, Qatar Fishing Company Production statistics. (Unpubl.) Doha, Qatar Fishing Company
1976-1977

Qatar, Ministry of Industry and Agriculture, Information Informal report. Qatar, Ministry
1978-1979 of Industry and Agriculture

Randall, J.E., G.R. Allen and W.F. Smith-Vaniz, Illustrated identification guide to commercial
1978 fishes. Rome, DP/RAB/71/278/3:221 p.

Saudi Arabian Fishery Development Project, Fish catch statistics for landing centres on the
1974-1977 Gulf coast. Dammam, Saudi Arabian Fishery Development Project, (Unpubl. rep.)

Scheffers, W.J., Results of the trawling operations carried out by the Ras Al Khaimah
1979 Fishing Company (U.A.E.). (Appendix 4 of the draft report: Demersal resources
of the Gulf and Gulf of Oman). RAB/71/278/6 (mimeo)

Sivasubramaniam, K., M. Lamboeuf, W.J. Scheffers, E.J. Simmonds and J. Vidal-Jünemann,
1981 Pelagic resources of the Gulf and Gulf of Oman. Rome, FAO, FI:DP/RAB/71/278/11:
(in preparation)

Statistical Centre of Iran, Statistical yearbook of Iran (March 1973-March 1974). Teheran,
1976 Statistical Centre of Iran, Serial No. 623

Thomas, D., Study of existing fishing gears and methods in artisanal fishery of the U.A.E.
1978 and suggested improvements. RAB/71/278 (mimeo)

Thomas, D., Study of existing fishing gears and methods in artisanal fishery of Bahrain and
1978 suggested recommendations. (mimeo)

University of Durham, Research and development surveys in North Oman. Durham, U.K.,
1978 University of Durham, vol.5:70 p.

Vidal-Jünemann, J., Frame survey for marine fisheries in Bahrain. Rome, FAO.
1979 FI:DP/RAB/71/278 (Restricted) (mimeo)

Yesaki, M., An analysis of the Taiyo Fishery Company operations off the southeast coast of
1978 Oman during 1976 and 1977. Report to the Government of Oman, 32 p. (MS)

Yesaki, M. and A.M.A. Al Harthy, A study of the artisanal fishery in the capital area of
1979 Sultanate of Oman (Unpubl. mimeo).

Part 1

DEMERSAL RESOURCES SURVEY CARRIED OUT BY THE PROJECT

by

K. Sivasubramaniam
Senior Fishery Biologist

1.1 INTRODUCTION

Over the last decade, the interest of the countries bordering the Gulf and the Gulf of Oman in the development of their fishing industry has grown by leaps and bounds. Besides the natural tendency for improvements and expansion of this industry as a result of the influence of general economic developmental trends in the region, a strong desire to diversify investments, coupled with awareness of the increasing demand for fish for human consumption as well as for animal feed, are significant factors contributing to the growth of the fishing industry.

Initially, the main development was that of a large-scale shrimp fishery in which heavy investments brought about a rapid increase in the rate of exploitation. This resulted in a serious decline in the shrimp stocks in some areas, which now appears to have reached a level demanding urgent management measures. However, with respect to the finfish fishery, the developments have been relatively slow and the lack of information on these stocks apart from short-term investigations and sporadic exploratory fishing activities has been one of the constraints. On the other hand, because of the importance of the petroleum industry in the Gulf, very good information on geological and certain physical oceanographic conditions is available.

In order to get a first estimate of the available resources, attempts were made to apply mean density and potential yield values from other areas with similar conditions to estimate the likely magnitude of the fish resources in the survey area but these were not meant to serve as a basis for planning fishery development or investments in this subregion (Gulland, 1971).

It was therefore, clear that available information on fish resources was far from sufficient for proper planning of fisheries development and that the only resources on which better information was available were the shrimp resources,which were already intensively exploited. The urgent need for a "survey of the fish resources to identify major pelagic and demersal fish resources, to determine abundance of their stocks, their distribution and seasonal variation and to estimate their potential yield" was recognized and became an important part of the Regional Fishery Survey and Development Project. A working group of experts met in September 1975 to develop the most appropriate survey design and working methods (FAO, 1976). It was concluded that a survey based on a random sampling programme, stratified by depth ranges,would be the best. The number of stations and details of the design were determined on the basis of estimated sea time for the research vessels made available to the project. It was anticipated that one coverage of the whole project area would be completed in one year and perhaps within half a year. This would permit a second coverage, on a reduced scale, within the same year, to study seasonal and other variations between coverages. On the recommendation of the 1st Ad Hoc Working Group, a firm of engineering consultants was requested to prepare a detailed work plan according to the guidelines presented by the Ad Hoc Working Group. Accordingly, Montreal Engineering Company Ltd., of Canada prepared all details of locations of each random station, number of stations in each substratum, allocation of stations to each vessel and other instructions. Forms for data collection were printed according to the recommendations of the working group. A provisional catalogue containing photographs of fish species in the survey area was prepared by a group of fish taxonomists recruited for this purpose. These and necessary guideline notes were distributed to each group participating in the survey programme.

1.2 SURVEY PLAN

The project area was divided into three areas, as follows:

Area 1 is bounded by the coastline of the head of the Gulf and a straight line connecting Ra's Rakan (Qatar) to Ra's-e Nay Band (Iran). To define the extremities of this line the navigation lights at both end points were used as reference. Therefore, the boundary of Area 1 is defined by the line joining light No. 0149.6, position 26°11.8'N latitude, 51°13.2'E longitude at Ra's Rakan and light No. 0304.9 position 27°23.2'N latitude, 52°34.7'E longitude at Ra's-e Nay Band. Since the light at Ra's Rakan is about one mile offshore, the boundary at this point goes to the western tip of the small island directly south of the light and then the nearest point of Qatar, along the low waterline.

Area 2 is bounded on the north by the above line, the coast of the Gulf and a straight line connecting the northern tip of (Jazirat) Masandam Island (Oman) to the midpoint of the mouth of the river (Rud-e) Gaz (Iran) and the 100 m contour. Thus, the eastern boundary of Area 2 runs from 26°23.0'N latitude, 56°31.7'E longitude to 26°27.5'N latitude, 57°03.8'E longitude. The western end of this line crosses Fakk al Asad at the narrowest point. Since no depths over 100 m are considered in Area 2, the region of deeper water extending into the Strait of Hormuz is defined as being part of Area 3.

Area 3 is bounded by the eastern boundary of Area 2, the coastline of the Gulf of Oman, and extends eastwards to the Iran-Pakistan border and Ra's Al Hadd (Oman). Both Iran and Pakistan claim 50 miles fishing limits, thus the survey area was extended to cover this limit from the Iran-Pakistan border. The eastern boundary of Area 3 runs from the Iran-Pakistan border to Gwater Bay at 25°10'N latitude, 61°33'E longitude to the outer edge of the fishing limit, 24°13'N latitude, 61°23'E longitude and thence along a straight line to light No. 0118, position 22°30.2'N latitude, 59°48.2'E longitude at Ra's Al Hadd.

It was not believed that the boundaries between areas have any implicit biological meaning in terms of stock distribution or movement patterns.

To allow for uncertainty in both navigational and chart reliability, the minimum depth to be sampled has been kept at 10 m. Since charts are based on least depths which could eliminate from the survey many marginal regions where operations could safely be carried out, only those regions where a depth of 5.5 m was indicated within the 10 m contour were excluded from the survey area; this includes all shorelines out to the first indication of 10 m depth. There are numerous pipelines and restricted areas containing wellheads, drilling rigs and loading platforms in the Gulf. Restricted areas and half a mile on either side of each pipeline were excluded from the survey area and indicated clearly in the overlays. The area southeast of Qatar, roughly south of 25°N, 5°30'E, is an area with a large number of shallow banks. Considering the hazards there and the fact that the Decca lattice on the chart was absolete, it was decided that this part of the Gulf could not be surveyed.

The survey area was further divided into strata on the basis of depth contours as follows:

Stratum A	10-25 m
Stratum B	25-50 m
Stratum C	50-100 m
Stratum D	100-200 m
Stratum E	200-300 m

Areas 1 and 2 contained strata A, B and C only, whereas Area 3 contained all strata. In areas where it was extremely difficult to differentiate a narrow stratum because of the steeply sloping bottom, the depth interval was included in the next depth stratum, e.g., strata A and B were always combined in Area 3. Each stratum within one area was divided into a number of substrata, in order to facilitate the study of differences in the abundance and distribution of fish in the different geographical parts in any one area. These stratifications and the codes used for identifying them are illustrated in Fig. 1.1.

Considering the total survey area, the number of vessels available and the sea time expected to be realized, it was determined that a total of 1 298 stations would be surveyed. The distribution of these stations was randomised by substratum, as described by Mackett (1973) and the number of stations to be allocated to each substratum was proportional to the ratio of the area of that substratum to the total survey area (Table 1.1A and Fig. 1.2). To identify any possible diurnal variation in the distribution of fish a day-night comparison was planned and about 88 stations were therefore identified at random as night stations. Contingency stations were also listed in case regular stations could not be carried out due to bottom conditions, unexpected caution areas, etc. No stations were indicated in known inaccessible areas, such as areas which were too shallow to allow fishing by the research vessels, caution areas or those very close to pipelines.

All vessels were using the same standard otter trawl (Engel high opening trawl), as specified by the 1st *Ad Hoc* Working Group and operational procedures were standardized. (For designs, see FAO, 1976.) All stations to be surveyed were indicated on chart overlays provided to each vessel. The principal method of positioning used was the Decca, but in areas which were not covered by a Decca lattice, the radar was utilized for positioning. If cases where this was impossible, some degree of positioning was to be realized through dead reckoning or compass navigation. The direction of the tow was randomly selected for each station, but in the event of unexpected difficulties in executing it accordingly, the direction could be changed with first consideration to the direction opposite to the given direction. The portion of the survey area to be covered by each of the survey vessels was selected with due weight given to the proximity to the base from which each vessel operated. The entire Iranian side of the Gulf was allocated to R/V LAVAN 03 (Iran), the area close to Iraq, Kuwait and Saudi Arabia was allocated to R/V SABAH (Kuwait), the waters around Bahrain, Qatar and west coast of UAE were assigned to R/V AL BAHETH (Bahrain) and the Gulf of Oman including Oman's waters west of the Strait of Hormuz were allocated to R/V DARBAT (Oman). The substrata and number of stations allocated to each vessel are presented in Table 1.1A.

1.3 IMPLEMENTATION OF THE SURVEY PLAN

Unexpected and unavoidable circumstances, including the UNDP financial crisis, caused delay in the implementation of the survey programme and consequently resulted in some objectives, such as seasonal variation studies not being satisfactorily accomplished (Table 1.1B).

The research vessel AL BAHETH (Bahrain) (formerly named LEMETCHE), the first to become available to the project, commenced operations in November 1976, followed by R/V DARBAT (Oman) in March 1977, R/V SABAH (Kuwait) in May 1977 and R/V LAVAN 03 (Iran) in October 1977. The characteristics of these vessels, the gear and operational standards were already presented in the report of the 1st Ad Hoc Working Group except for R/V LAVAN 03, which is a 32.6 m steel trawler with a MAN/850 HP engine, and equipped with Sounder, Sonar, Decca, R.T. etc.

One of the basic operational requirements for all vessels participating in the demersal survey was that the Engel high opening trawl with a 32 mm mesh size codend, should be towed at a speed of about 3 knots for a duration of about one hour while maintaining a horizontal opening of about 20 m between wing tips.

(1) The layout of the cruise log, fishing log, biological sampling sheet and length frequency sheet as illustrated in the report of the Working Group (FAO, 1976) was modified for using various codes to suit data processing by computer.

(2) The layout of the modified log sheet is given by Flowers (1978).

(3) At each haul, according to instructions provided in this document, the observations on location, date, time, total catch, catch by species or species groups in number and weight were recorded on printed forms.

Oceanographic conditions generally observed were surface temperature, bathythermograph readings and type of bottom.

The catch, or a representative sample of the catch was sorted by species or by species groups, where identification to species level was difficult, and the weight by species or species group determined.

The identification of species was initially facilitated by the use of provisional copies of the Fish Identification Guide and subsequently by using the published version of this Guide (Randall, Allen and Smith-Vaniz, 1978), prepared by specialists on taxonomy of fishes. Biological information collected was mainly data on length frequency and, whenever time permitted, length-weight data, sex ratio, maturity of gonads and stomach contents were also investigated. An attempt to build up a collection of identified species for each member country did not materialize effectively. However, in a few cases the biologists assisted in the collection of specimens for national laboratories and related institutions in the region.

In view of difficulties faced with maintaining the scheduled programme for the vessels and equality in sea time for all project vessels, some reallocation of survey stations was carried out from time to time. It also became evident that a fair number of the selected survey stations could not be trawled for various reasons. Some were in depths shallower than expected, too shallow to be fished by the vessels,others were in areas which could not be reached due to very shallow entrances, while some of the stations were in caution areas unknown at the time of station determination. Furthermore, the bottom conditions at a substantial number or stations were found to be too rough to be trawled by the standard survey trawl at all or the risk of severe damage to the gear was considered too high by the masterfisherman. In view of the extremely limited repair capacities on some vessels severe damage would have lead to unacceptable delays in the execution of the survey programme.

All these stations which could not be investigated, for one reason or another, were declared as "untrawlable stations" for data processing purposes. The fact that most of these stations could possibly be trawled either with the standard trawl, but at a high risk to the net, or by using modified trawls suited to the rough bottom conditions, was realized.

The meeting of the Second Ad Hoc Working Group on Survey Technique and Strategy, held in April 1978, after reviewing the progress made, expected the first coverage of the survey area (First Phase) to be completed by June 1978, but this was realized only by the end of August 1978. On the basis of the progress, findings and requirements of the survey, this Working Group recommended modifications to the survey programme (Second Phase) for the period June 1978 to March 1979, as detailed in its report (FAO, 1979). Accordingly, approximately 50 percent of the declared "untrawlable stations" in each substratum were selected at random and attempted either with the standard trawl or a modified standard gear or a rough bottom trawl, in that order of preference. The remaining 50 percent of the untrawlable stations were eliminated from the survey plan. Of the total survey time for the Second Phase, 70 percent was set aside for the rough bottom areas, of which two thirds formed part of the survey plan, while one third was used to obtain information on indicative catch rates, The remaining 30 percent of the time was allocated to indicative fishing on both smooth and rough bottom.

Again due to unprecedented loss of sea time, the programme for the Second Phase had to be modified and then priority was given to coverage of certain substrata, such as those south of Bahrain (1A5), and southeast of Qatar (2A1, 2A2) with large clusters of "untrawlable stations" over the other substrata which had only scattered untrawlable stations. The survey vessel LEMURU, usually employed in the pelagic survey also was used in implementing this programme.

This programme modification, the chartering of a trawler from the Bahrain Fishing Project and the extension of the indicative fishing operations beyond March 1979, allowed an increase of the proportion of the sea time used for indicative fishing during the Second Phase. The alloted time for this subject thus became more than that was recommended by the Second Ad Hoc Working Group. The actual number of stations trawled during the two phases of the survey is given in Table 1.1A by substrata and month.

The results of the surveys as presented in this report are summaries of the data contained on the various logs, which have been transferred to punch cards and are stored on a number of computer tapes.

All countries participating in the surveys received copies of the printouts as listed in the following paragraph. The tapes are available at FAO Headquarters for further analyses if required.

The time between cruises was made use of to collect information on catches by existing fisheries in the various countries, in order to obtain data on the present level of exploitation and seasonal trends, since the latter could not be obtained satisfactorily from the survey results. The result of this work is presented in Part 3 of this report.

1.4 METHODS OF DATA ANALYSIS

The data collected were processed for computer analysis as detailed in the computer programme (Flowers, 1978). The programming provided the following printouts:

(a) A complete compilation of all the data collected on the catch quantities by species, by haul with all details collected for each haul.

(b) Average catch per hour of trawling, for the total catch and catch by species and species groups, for each stratum and area.

(c) The percentage species composition by stratum and area.

(d) Maps of the total catch per hour at trawlable stations, and indication of the untrawlable stations in the whole survey area.

(e) Maps of the catch per hour for a number of species or species groups selected on the basis of their commercial importance or predominance in the catch.

(f) Mean density per square kilometre , the variance, and mean biomass with 90 percent confidence limits for respectively the total catch, the catch of commercial species and the catch of noncommercial species for each substratum and area.

(g) The same analysis as in (f) carried out for each of the species groups selected on the basis indicated in (e).

(h) Length frequency distribution patterns for species or species groups by substrata. The samples were raised to the total weight of the catches of the respective groups and then the average length compositions were calculated for the sampled stations.

The area covered by the net during a haul has been determined from the measured speed of the net through the water, average 3 knots, and the estimated distance between the tips of the wings of the trawl. This estimate was obtained by calculating the distance between the otterboards from the measured angle between the trawl warps and the length of the warps. The distance between the wing tips was then estimated to be 40 percent of the distance between the otterboards. The figure of 40 percent was derived from the general configuration of the net and the sweeps (length of sweeps 50 m, bridles 30 m and headrope 50.5 m) and from practical observations about net performance at sea (see FAO, 1976).

The sweeps and bridles will herd part of the fish encountered during trawling towards the centre, in the path of the net. On the other hand, some of the fish already in the path of the net will escape e.g., through the large meshes. These two factors, concentration of fish by the sweeps and escape from the net, more or less counterbalance each other and it has been assumed that the quantity of fish caught in the trawl is equal to the quantity of fish which was originally present in the path of the net. In the absence of detailed knowledge about the behaviour of the fish in relation of the trawl used, it is not possible to decide whether this assumption is approximately correct or has led to an over- or underestimate of the biomass.

From the estimates of the quantity of fish present in the area covered by the net at the various stations in a substratum, the average density of the fish per square kilometre in that substratum was calculated. Multiplication of the density per square kilometre by the size of the substratum gave the biomass in the substratum, and summation of the substratum estimates gave estimates by stratum, area or total project area as required. Thanks to the random sampling design of the survey, the calculations could at the same time provide an estimate of the possible error due to sampling variation. The biomass estimates are only given as average figures calculated from the data. The 90 percent confidence limits of these estimates (i.e., the limits within which, with 90 percent probability, the true biomass value will lie if the basic assumption on the gear efficiency is correct) are given on the computer printouts made. The "t" distribution has been used to calculate confidence limits to the estimates of mean density and biomass.

In view of the changes in the random selection of stations for the Second Phase and the introduction of modifications to the sampling gear to operate on rough bottom, the data from the Second Phase of the survey programme were analysed independently.

Biological data such as length-weight relationship, maturity, stomach contents, species distribution and the data on environmental factors, were processed without computer.

1.5 SURVEY RESULTS

1.5.1 Species Composition

The survey detected over 250 species belonging to over 100 families, not all commercially valuable in the two Gulfs. About 38 families are considered to be noncommercial in other parts of the world. A list of the species groups presently considered as unmarketable in most or all of the countries bordering the project area is given in Table 1.2. This list includes those species which are presently marketed in some places in the area but not accepted elsewhere (e.g., catfish, flatfish, etc.) and also species which are marketed in other parts of the world and mav become marketable in the region in the near future.

There were problems in the identification of the species caught because of the lack of suitable reference books, but this situation improved considerably after the completion of a guide for the identification of fishes in the survey area by specialists engaged by the project. Also, on several occasions, the available time between tows was insufficient for careful examination of the fish caught for identification and separation of species, especially the more difficult ones, and, hence, in such instances some species were recorded only under the family. As a result, every catch was recorded to the same level of specification. Several fishes may have been recorded by their specific name in one haul under their generic name or sometimes even under their family name in other hauls. The genus or family groups may therefore include species which at times have been recorded under their specific name.

The number of species and species groups recorded in a single haul is rather restricted and averaged about 25, with few species or species groups dominating the catch sometimes. But, within a substratum, the total number of species or species groups encountered is high generally varying between 15 and 50, depending on the location of the substratum and the fishing season. A detailed species composition in each substratum is given in Tables 1.12, A-C.

Because of the large number of species in the catches, most of the individual species groups formed only a small part of the total catch. The most important groups are given in Table 1.3.

Eighteen families or species groups contributed over 2 percent to the catches made in Areas 1 and 2 (the Gulf) and the Gulf of Oman, and of these only about nine groups or families were common to both Gulfs, namely Leiognathidae, Carangidae (large and small), Mullidae, Synodontidae, Nemipteridae, Lethrinidae, Dasyatidae, Pomadasyidae. The remaining nine groups or families with more than 2 percent in the total catch composition were Ariommidae, Ariidae, Carcharhinidae, Lutjanidae, Clupeidae and Sphyraenidae in the Gulf and Gerreidae, Trichiuridae and Cephalopods in the Gulf of Oman.

Six species groups or families in the Gulf and five species groups in the Gulf of Oman contributed about 50% of the average catches in the two Gulfs. Only Leiognathidae and Carangidae in the Gulf, and Nemipteridae and Pomadasyidae in the Gulf of Oman, contributed more than 10% of the total catch in the respective areas. It should be noted that, of these groups discussed above, Leiognathidae, Synodontidae and Trichiuridae are on the list of unmarketable species. The first, Leiognathidae, appears to be the most predominant in the Gulf. Seven of the noncommercial or presently unmarketable species groups are included in Table 2.3, and these form nearly 30% and 25% of the total catch composition in the Gulf and Gulf of Oman respectively. Adding to these figures the unmarketable species groups included in the group "others", the percentages of unmarketable species in the catches become 37.4% and 36.6% for the Gulf and Gulf of Oman, respectively.

There is less marked variation between Areas 1 and 2. Of the 15 significant species groups or families in the Gulf (greater than 2%), 12 were common to Areas 1 and 2, while three - Lethrinidae, Dasyatidae and Sphyraenidae were below 2% in Area 1 but not in Area 2.

It is evident that the various species groups or families are not evenly distributed in the survey area, as could be expected in view of the variations in the environmental conditions, particularly the characteristics of the bottom. Hence, the differences in the distributional patterns not only contribute to variations in the species composition between strata but also within strata and this will be clearly evident when the distribution patterns of some of the predominant species groups are discussed. The basic differences in the type of bottom (and other environmental factors) on the Iranian and Arabian sides of the entire survey area seem to introduce significant differences in the species compositions of these two sides. Whereas Leiognathidae and Ariidae are more abundant on the Iranian side, Serranidae, Lethrinidae, Nemipteridae and Clupeidae exhibit a higher relative abundance on the Arabian side of the Gulf. In the Gulf of Oman, though Nemipteridae is the predominant family on both sides, Lethrinidae, Serranidae and Pomadasyidae were more abundant on the Arabian side, while cephalopods and crustaceans were more abundant on the Iranian side (Tables 1.12A-C)

The "others" category in Table 1.3 and Tables 1.12A-C include all remaining groups which form together about 75% of the total number of species groups in the area while none of the groups constituted more than 0.8% of the catch. The commercial species included in this category contributed only 1.7%, 2.2% and 0.5% for Areas 1, 2 and 3, respectively. Of which Scombridae and Siganidae were the most important.

In general, the project area is typical of tropical waters where a trawl fishery has to be directed at a large mixture of species rather than at a few selected species, as is the case of most temperate waters. There appear to be few species or species groups which by themselves contribute substantially to the total demersal fish biomass and those have often a low market value. This is very relevant to any plans for developing a demersal fishery in the areas surveyed.

1.5.2 Distribution of Catch Rates

The catch rates per station varied considerably, not only in the area as a whole but also within substrata. This is a common feature of trawl catches and is the reason why a large number of stations were required to determine mean fish density in the different parts of the survey area. For the project area as a whole, the catch rates for all species varied between 6 kg and 4 022 kg per hour of trawling. As an example of a substratum with moderate variation in catch rate, substratum 1A3 can be mentioned, where the catch rate ranged between 123 kg and 1 563 kg per hour of trawling. These differences are due not only to real differences in fish densities between the stations but also due to differences in the performance by the gear at different stations in relation to type of bottom, fish behaviour, current, time of the day or other factors.

Table 1.1A

NUMBER OF STATIONS ALLOCATED AND TRAWLED IN 1st AND 2nd PHASE OF SURVEY, BY SUBSTRATUM

Substratum	Number of stations						Percentage of original allocation trawled in Phases 1 & 2
	First phase 1/				Second phase		
	Allocated		Trawled		Reallocated	Trawled	
	Day	Night	Day	Night	Day/Night	Day/Night	
1A1	25	2	18	1	27	0	70.4
1A2	44	4	16	1	13	0	35.4
1A3	34	3	16	2	9	0	48.6
1A4	28	2	9	0	6	1	33.3
1A5	14	1	0	0	7	7	46.7
1B1	61	4	38	1	10	0	60.0
1B2	121	8	84	6	8	0	69.8
1B3	29	2	19	0	2	1	64.5
1C1	60	4	47	0	6	0	73.4
1C2	90	6	81	3	0	0	87.5
2A1	105	9	14	0	0	9	20.2
2A2	82	7	19	0	26	9	35.5
2A3	13	1	8	0	4	1	64.3
2B1	22	2	13	1	6	0	65.3
2B2	21	1	15	0	0	0	68.2
2B3	58	4	50	0	4	6	90.3
2B4	58	4	17	0	19	18	56.5
2B5	15	1	6	0	7	6	75.0
2C1	55	4	6	1	18	0	11.9
2C2	109	8	63	0	17	0	53.8
2C3	75	5	58	0	8	1	73.8
3B1	15	1	15	1	0	0	100.0
3B2	6	0	4	0	0	0	66.7
3B3	2	0	1	0	0	0	50.0
3B4	11	1	7	0	0	0	58.3
3B5	15	1	15	0	0	0	93.8
3C1	8	1	8	0	0	0	88.9
3C2	6	0	5	0	0	0	83.3
3C3	13	1	5	0	0	0	35.7
3C4	17	1	3	0	0	0	16.7
3D1	5	0	2	0	0	0	40.0
3D2	5	0	2	0	0	0	40.0
3D3	32	0	3	0	0	0	9.4

(continued)

Table 1.1A (cont'd)

	Number of stations						Percentage of original allocation trawled in Phases 1 & 2
	First phase 1/				Second phase		
Substratum	Allocated		Trawled		Reallocated	Trawled	
	Day	Night	Day	Night	Day/Night	Day/Night	
3E1	7	0	2	0	0	0	28.6
3E2	11	0	2	0	0	0	18.2
3E3	10	0	0	0	0	0	0.0
3E4	12	0	7	0	0	0	58.3
3E5	4	0	0	0	0	0	0.0
Area 1	506	36	328	14	88	9	65.8
Area 2	613	46	269	2	109	50	52.4
Area 3	179	6	81	1	0	0	44.1
Total	1 298	88	678	17	197	59	54.4

1/ 512 stations were found to be "untrawlable" with the standard sampling gear, part of these stations were reallocated in the 2nd phase to be fished with modified gear

Table 1.1B

SEASONAL DISTRIBUTION OF DAY-TIME TRAWL HAULS BY SUBSTRATUM

Substratum	Jan.	Feb.	March	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Quarter			
													1	2	3	4
1A1	2									13	2	2	2	0	0	17
1A2					9	7							0	16	0	0
1A3		4	8			4							12	4	0	0
1A4			2		1	4		1	1		1		2	5	2	1
1A5											7		0	0	0	7
1B1	2			1						20	11	4	2	1	0	35
1B2			2		18	43	16	6					2	61	32	0
1B3	1		6	2	2	5		1	3				7	9	4	0
1C1			1		34				7		4	1	1	34	7	5
1C2	1		36			21	16	7				1	37	21	23	1
2A1					1	5	6		2		9		0	6	8	9
2A2				15	1		2			1	9		0	16	2	10
2A3	1			8									1	8	0	0
2B1				13									0	13	0	0
2B2	5		2	8									7	8	0	0
2B3	4		4	3	2	7	22		7	5	2		8	12	29	7
2B4	2			5	7					5	16		2	12	0	21
2B5	6			1	5								6	6	0	0
2C1				2			4						0	2	4	0
2C2	9		4	13	7	18				12			13	38	0	12
2C3	1		3	25	28		1			1			4	53	1	1
3B1					15								0	15	0	0
3B2					1			3					0	1	3	0
3B3								1					0	0	1	0
3B4			7										7	0	0	0
3B5			12				3						12	0	3	0
3C1					8								0	8	0	0
3C2					3			2					0	3	2	0
3C3						1		4					0	1	4	0
3C4			3										3	0	0	0
3D1					2								0	2	0	0
3D2								2					0	0	2	0
3D3			1				1	1					1	0	2	0
3E1								2					0	0	2	0
3E2								2					0	0	2	0
3E3													0	0	0	0
3E4			4				3						4	0	3	0
3E5													0	0	0	0
Totals	34	4	95	96	144	115	74	32	20	57	61	8	133	355	126	136
Area 1	6	4	55	3	64	84	32	15	11	33	25	8	65	151	58	66
Area 2	28	0	13	93	51	30	35	0	9	24	36	0	41	174	44	60
Area 3	0	0	27	0	29	1	7	17	0	0	0	0	27	30	24	0

Table 1.2

SPECIES AND SPECIES GROUPS ENCOUNTERED IN THE GULFS,WHICH ARE CONSIDERED UNMARKETABLE IN MOST OF THE AREA

*1.	Albulidae	Bonefish
*2.	Antennaridae	Frogfishes
3.	Apogonidae	Cardinalfishes
**4.	Ariidae 1/	Catfishes
*5.	Balistidae	Filefish/triggerfish
6.	Batrachoididae	Toadfishes
7.	Blennidae	Blennies
**8.	Bothidae (Arnoglossus)	Lefteye flounders
9.	Selaroides (Carangidae)	Slender scaled scad
*10.	Carchariidae	Shark
11.	Centriscidae	Shrimpfishes (razorfishes)
12.	Cepolidae	Bandfishes
13.	Chaetodontidae	Butterflyfishes
*14.	Congridae	Conger eels
**15.	Cynoglossidae	Tonguefishes
16.	Dactylopteridae	Flying gurnards
*17.	Dasyatidae 1/	Sting rays
18.	Gymnuridae	Butterfly rays
19.	Diodontidae	Porcupinefishes
20.	Echeneidae	Remoras
21.	Fistularidae 1/	Trumpetfished
22.	Gerreidae (Pentaprion sp.)	Mojarras
23.	Leiognathidae 1/	Ponyfishes
*24.	Menidae	Moonfish
25.	Mobulidae	Manta ray
26.	Monocanthidae	Leather jackets
27.	Monodactylidae	Fingerfishes
*28.	Mugiloididae	Sandperch
*29.	Muraenosocidae	Pike congers
*30.	Myliobatidae	Eagle rays
31.	Ophichthidae	Snake eels
32.	Orectolobidae	Carpet sharks
33.	Ostraciontidae	Boxfishes
34.	Pegasidae	Seamoths
**35.	Platycephalidae	Flatheads
36.	Plotosidae	Catfish eels
37.	Pomacanthidae	Butterflyfishes
38.	Pomacentridae	Damselfishes
*39.	Rhonciscus sp. (Pomadasyidae)	Grunts
**40.	Pristidae	Sawfishes
41.	Pseudorhomidae	Dotty backs
*42.	Rhinobatidae	Guitarfishes
43.	Rhincodontidae	Whale shark

Table 1.2 (cont'd)

44. Scatophagidae	Scats
*45. Scorpaenidae	Scorpionfishes
46. Soleidae	Soles
**47. Sphyrnidae	Hammerhead sharks
48. Syngnathidae	Pipefishes
**49. Synodontidae 1/	Lizardfishes
50. Tetraodontidae	Puffers
*51. Theraponidae 1/	Therapon perches
52. Torpedinidae	Electric rays
53. Triacanthidae	Triple spines
*54. Trichiuridae 1/	Cutlassfishes/hairtails
55. Trigliidae	Searobins
56. Uranoscopidae	Stargazers

* Families or species considered marketable in many countries outside the Gulfs areas

** Marketable in very limited quantities in the area

1/ Groups of species discussed separately in biomass estimates, etc. (e.g., Table 1.3)

Table 1.3

COMPARISON OF THE SPECIES COMPOSITION IN THE TWO GULFS
(LISTED IN THE DESCENDING ORDER FOR THE GULF TOTAL)

	Family or species group	Area 1	Area 2	Total (Gulf)	Area 3 (Gulf of Oman)
1.	Leiognathidae 1/	19.3	6.0	12.7	4.1
2.	Small Carangidae	12.3	11.3	11.9	2.6
3.	Mullidae	11.4	7.4	9.4	3.0
4.	Synodontidae 1/	5.9	8.6	7.3	4.8
5.	Ariommidae	8.4	5.7	6.8	0.0
6.	Nemipteridae	3.6	6.8	5.3	18.9
7.	Large Carangidae	4.3	5.6	4.8	6.0
8.	Ariidae 1/	4.9	4.0	4.5	1.1
9.	Lethrinidae	0.9	7.1	4.1	5.9
10.	Carcharhinidae	3.8	3.1	3.4	1.5
11.	Clupeidae	2.5	3.8	3.2	0.9
12.	Dasyatidae 1/	1.7	4.3	3.0	3.3
13.	Pomadasyidae	2.7	2.9	2.8	12.3
14.	Lutjanidae	2.3	3.1	2.7	1.9
15.	Sphyraenidae	1.1	3.2	2.2	1.7
16.	Serranidae	1.2	1.9	1.6	1.9
17.	Theraponidae 1/	1.3	1.5	1.5	0.1
18.	Sparidae	1.0	1.1	1.1	1.7
19.	Trichiuridae 1/	0.6	0.8	1.1	6.3
20.	Gerreidae 1/	0.2	0.9	0.7	5.5
21.	Sciaenidae	0.4	0.6	0.5	1.1
22.	Crustacea	0.6	0.4	0.5	0.3
23.	Mollusc/Cephalopods	0.2	0.3	0.3	3.2
24.	Others (Commercial)	1.7	2.2	2.0	0.5
	(Noncommercial)	7.5	6.6	6.6	11.4
	Commercial groups (%)	58.5	67.3	62.6	63.4
	Noncommercial groups (%)	41.5	32.7	37.4	36.6

1/ Noncommercial groups

Because of this high variation, the estimates of fish density by substratum have, in general, wide confidence limits which means that the real average density of fish per stratum may be higher or lower than the estimate from the survey. Therefore, in some cases the differences between the average densities in the different substrata may be due to the sampling error rather than the real differences in density. However, notwithstanding this proviso, it appears that the density distribution mappings by substrata do present fairly clear distribution patterns for the various fish species and species groups in the area.

The average catch rate is proportional to the mean density of the fish. In the survey experiments, considering the specification of the survey trawl gear and the standards of operation maintained, the area effectively swept by the gear in one hour was estimated as one ninth of a square kilometre. Therefore, the density per square kilometre is taken as nine times the average catch rate per hour. The mean density values have been estimated for the purpose of calculating biomass values but for ready evaluation of actual catch differences the mean catch rate (catch/kg) per hour of trawling has been used in discussing the distribution of various species groups in the various substrata.

The data of average catch rate by substratum obtained during the survey are presented in Figs. 1.3 to 1.22. The figures have been prepared for the catches of all species together, for the commercial species alone, and for several species and species groups separately. The figures combine the information obtained during the First Phase of the survey with the standard survey trawl, with that obtained during the Second Phase in the rough ground areas, when sometimes trawls adapted to the rough bottom had to be used. It has been assumed in the present analysis that the fishing efficiency of the different trawls was the same per unit of area covered by these trawls. Substrata surveyed partly or wholly during the Second Phase include substrata 1A5, 2A1, 2A2, 2B3 , 2B4 and 2B5 (Table 1.1A). For all other substrata which contained so-called "untrawlable stations" during the First Phase, it has been assumed that the average fish densities in the "untrawlable" parts of the substratum was equal to the average density in the actually surveyed part.

When the mean catch rates of adjacent substrata are different, this appears as an abrupt change at the boundary between the substrata as evident from the distribution maps. In reality the change in fish density will be gradual and irregular. However, the given values provide the best available picture of the average condition in each substratum.

Fig. 1.3 illustrates the average catch rates per substratum obtained for all species together. The figure shows that there are large differences in the average catch rates between substrata, within the same area. Thus, in Area 1 the average total catch rates range from 272 kg/h (substratum 1C1) to 1 071 kg/h (substratum 1B1), in Area 2 from 181 kg/h (substratum 2C3) to 1 378 kg/h (substratum 2(A)B2), and in Area 3 from 180 kg/h (substratum 3D2) to 1 390 kg/h (substratum 3C1).

In general throughout the Gulf, the 25-50 m depth zone (Stratum B) appears to have given catch rates which were in some cases equal to but mostly higher than the shallower and deeper zones in the same neighbourhood; only near the Strait of Hormuz the catch rate was higher in the 50-100 m range (Stratum C) than in the 25-50 m range on the Arabian side. Both in Strata A and B (10-25 m and 25-50 m range), the average catch rates were higher along the Iranian side of the Gulf than along the Arabian side within each area. Mean catch rates of over 900 kg/h were obtained in all the substrata within the 25-50 m range along the Iranian side, whereas the catch rates in this depth zone along the Arabian side were mainly between 500 and 700 kg/h. However, it must be mentioned that the survey of the Iranian side was done in the winter months, while the rest of the survey area was mainly covered between March and October.

The lowest average catch rates per substratum, between 100 and 300 kg/h have been observed in the 10-25 m depth zone around Qatar and Bahrain, and in the 50-100 m depth zone in the central part of the Gulf north and northeast of these countries.

In the Gulf of Oman the catch rates of over 900 kg/h were obtained in deeper water, in one substratum in the 50-100 m depth zone on the Arabian side and one in the 100-200 m depth zone on the Iranian side. In this area, catch rates below 300 kg/h were only observed in one substratum on the Iranian side (3B2).

During the trawl survey, significant quantities of small and large pelagic species groups also entered the catch and these have been included in the catch rates discussed above. The pelagics entering the trawl catches were mainly small Carangidae, such as scad and horse mackerels, followed by king mackerel, sardines, Indian mackerel and anchovy. In order to determine the distribution pattern for the demersal species only, catch rates were determined after deducting the catches of pelagic species mentioned above (Fig. 1.4). This, however, did not alter the general distribution pattern but the actual catch rates were reduced approximately by 15% in the Gulf and 5% in the Gulf of Oman.

The average catch rate of those species together, which have been defined as marketable for the present purposes, are shown in Fig. 1.5. In general, the distribution of these species groups together show a pattern similar to that of all species together. The average catch rates by substratum varied between 101 and 1 034 kg/h (substrata 2A1 and 3D1 respectively). Relatively high average catch rates in the Gulf were again obtained in the shallower waters, down to 50 m depth, along the Iranian side, ranging from over 400 to over 800 kg/h, the best area being substratum 2(A)B2. In the 25-50 m depth zone along the Arabian side, the average catch rate varied between over 300 to over 500 kg/h, the best area being close to the Strait of Hormuz. The poorest substrata were again those in the 10-25 m depth zone around Bahrain and Qatar, and the 50-100 m depth zone northeast of Qatar, with average catch rates between 100 and 200 kg/h.

In the Gulf of Oman only one substratum gave a catch rate below 200 kg/h. Catch rates over 500 kg/h were observed on the Oman side towards the entrance of the Strait of Hormuz and along the Iran coast, in water over 100 m deep, with substratum 3D1 having an average of over 1 000 kg/h.

The pelagic species mentioned above as appearing in trawl catches are all commercial species and hence have all been included in the catch rates discussed here. The result is that these pelagic species (Figs. 1.8, 1.21 and 1.22) have even greater significance for the catch rates of commercial species groups than for the catch rates of all species groups and generally the contribution by these pelagics to the catch rates of commercial species groups was approximately 30 percent. Hence the catch rates of the purely demersal species and species groups of commercial value will be considerably lower than those shown in the map for all commercial species together.

The average catch rates of the species and species groups together which are presently unmarketable in the region, including a few species which are found in the markets of some countries in the project area, are shown in Fig. 1.6.

High catch rates of over 800 kg were observed in the substratum 3C4 on the Arabian coast of the Gulf of Oman. The catch rates were more than 400 kg along the Iranian coast of the two Gulfs. In almost all other substrata the catch rates were equal to or less than 200 kg/h. Very low catch rate values were observed in the deep central part of the Gulf, where catch rates for commercial species groups were also low.

1.5.2.1 Catch/rates by species groups

The distribution patterns discussed above represent the combined distribution patterns of various species groups and in order to understand the distribution by individual groups, the catch rates per substratum were analysed by species groups. About 15 groups were selected for such a study and these were selected on the basis of their popularity as food fish, significance of their contribution to the catch, and others because they are pelagics entering demersal catches.

(a) Carangidae (trevally, scads and horse mackerel (Figs. 1.7 and 1.8)) evidently is the species group which forms the highest percentage of commercially valuable groups. A major component of this group is pelagic in habitat and if the smaller carangids, such as scads and horse mackerel, are deducted from the group the remainder would be only about 16 percent of the total for the group (Fig. 1.7).

The small carangids were the main contribution to the group in the Gulf (85 percent in Area 1 and 90 percent in Area 2) but in the Strait of Hormuz and Gulf of Oman larger carangids generally formed the major component of this group (Fig. 1.8). In the Gulf of Oman substrata with relatively high catch rates showed higher composition of small carangids. Therefore, the general distribution patterns of small carangids in the Gulf coincides reasonably well with that for the whole group, except in the case of substratum 1A1, where there was a predominance of large carangids. For the group as a whole, in the Gulf, catch rates of over 100 kg/h were mainly found along a large part of the coast of Iran in water shallower than 50 m, in a large part of the 25-50 m depth zone on the Arabian side, and in the deep water in the middle part of Area 2 (substratum 2C2). In the Gulf of Oman, more than 100 kg/h was observed on the Iran coast in substratum 3C2, and on the Arabian side close to the Strait of Hormuz.

It also appears that, among the small carangids, Decapterus sp. was dominant on the Iranian side, Selar sp. close to UAE and Trachurus sp. in the middle part of the Gulf. On the other hand, in the Gulf of Oman good concentration of Selar sp. was observed in 3C2 substratum while Decapterus is sparsely spread over all the substrata B, C and D.

(b) Mullidae (Goatfishes (Fig. 1.9)) is the second most abundant commercial species group in the Gulf (9.4 percent). This species group is mainly concentrated in the shallow waters along the Iranian side (10-50 m) and in the northwest end of the Gulf, with catch rates in the best areas of over 150 kg/h.

(c) Ariommidae (Driftfishes (Fig. 1.10)), on the contrary, are mainly concentrated in the deepest part of the Gulf (50-100 m), with the highest catch rate of about 145 kg/h in the middle of zone C. This species group is found in reasonable quantities only within the Gulf, and is scarce towards the Strait of Hormuz and the Gulf of Oman.

(d) Nemipteridae (Threadfin breams (Fig. 1.11)) show just the opposite. They are found mainly in the deeper waters of the Strait of Hormuz and the Gulf of Oman, in concentrations of over 200 kg/h, whereas this group is very scarce in the northwest end and along the Arabian side of the Gulf.

(e) Lethrinidae (Emperorfishes, (Fig.1.12) Lutjanidae (Snappers, Fig. 1.13) and Serranidae (Groupers, Fig. 1.14). These species groups were concentrated along the Arabian coast. The highest concentrations were mainly found in the 25-50 m depth zone from northwest of Bahrain to the Strait of Hormuz and good concentrations were alos found on the

Arabian side of the Gulf of Oman. The average catch rates for the substrata with the highest density for each group within the Gulf were over 120 kg/h, 74 kg/h and 23 kg/h respectively.

(f) Pomadasyidae (Grunts (Fig. 1.15)) catch rates were relatively higher in the B stratum (25-50 m) in the southeastern part, A stratum (10-25 m) in the northwestern part of the Gulf, and C stratum (50-100 m) near the Strait of Hormuz. In the Gulf of Oman, catch rates were higher on the Iranian side, particularly in the B stratum, whereas near the Strait of Hormuz high catch rates were realized in the C and D strata. The highest catch rate was in 3C4 substratum (530 kg/h) close to the Strait of Hormuz. The central deep part of the Gulf revealed very poor concentrations.

(g) Carcharhinidae (Requiem sharks (Fig. 1.16)) showed an evenly low catch rate pattern for all substrata. The highest catch rate obtained was 56 kg/h; except for this most of the catch rates per substratum ranged between 20 kg and 30 kg/h. Extremely low values were from the substrata around Qatar and Bahrain and from both sides of the Gulf of Oman. This group is considered as one of the poorly priced commercial species groups.

(h) Leiognathidae (Ponyfish/slipmouth (Fig. 1.17)) is the most abundant noncommercial species group in the project area. This group is mainly concentrated on the Iranian side of the project area, both in stratum A and stratum B, with catch rates ranging from 116-419 kg/h. On the Arabian side of the Gulf, the catch rates in any substratum did not exceed 20 kg/h but the Arabian side of the Gulf of Oman showed relatively higher catch rates of 32 kg and 75 kg/h. This group was poorly represented in the waters deeper than 50 m.

(i) Synodontidae (Lizardfishes (Fig. 1.18)) is the second most abundant noncommercial species group in the project area. In the Gulf, catch rates of over 50 kg/h were observed in 25-50 m along the Iranian side and in all depth zones in the eastern half of Area 2, excluding the deeper part of the Strait of Hormuz. In the Gulf of Oman, such catch rates occurred in the same depth range on the Iranian and Arabian sides but only in two substrata. In all other substrata in the two Gulfs the catch rates were evenly low and below 25 kg/h. Except for the Iranian coast, the catch rate appeared to be greater in Area 2 than in Area 3 or Area 1. Saurida tumbil commonly appeared in the catches from the Iran side and S. undosquamis was more widely spread with a tendency to enter coraline areas. The former was common in the Gulf of Oman too.

(j) Ariidae (Catfishes (Fig. 1.19)) mainly concentrated in the A and B strata along the Iranian coast of the Gulf and close to the Shatt Al Arab. In all other areas, including the Gulf of Oman, the catch rates were generally below 25 kg/h. The distribution pattern resembles that of the Leiognathidae. This group is relatively poor in the Gulf of Oman but even in the Gulf the highest catch rate was only 91 kg/h.

(k) Gerreidae (Mojarras (Fig. 1.20)) a group with poor abundance in the entire project area and its 5 percent contribution to the catch from the Gulf of Oman was due to the unique catch rate of 150 kg/h in the substratum 3E5 on the Arabian side. In all other substrata the catch rates were evenly low and well below 15 kg/h. Even this poor representation seems to indicate a tendency for the group to be more in shallow waters than in depths greater than 50 m. It is significantly poor in the Strait of Hormuz.

(l) Crustacea (Shrimps and lobsters, no figure) as a whole, were poorly represented in the catches and formed less than 0.5 percent of the total. The two species groups mainly contributing to the catches were Penaeidae (shrimps) and Thenus orientalis (slipper lobster).

The Palinuridae (spiny lobster) were negligible in trawl catches. The slipper lobster was caught mainly in Area 2, the catch rates were fairly even in all substrata except on the Iranian side and the Strait of Hormuz. The highest catch rate of 8.1 kg/h was from a shallow substratum (2A3) close to the west coast of UAE. In Area 1 they were almost absent except in 50-100 m depth zone. In the Gulf of Oman the results were better than in Area 1.

As the trawl gear used was not very efficient for sampling shrimps, the results of the shrimp catches were not only poor but may not be representative. Further, the distribution of this group has already been dealt with elsewhere (FAO, 1977a) and hence it is not discussed in the present report.

(m) Sepiolidae and Loliginidae (squids and cuttlefish, no figure) formed a negligible percentage of the catch in the Gulf but formed about 3 percent of the catch in the Gulf of Oman. In view of the interest shown by joint venture companies to exploit this resource for export, it was considered useful to examine the distribution pattern projected by the trawl survey. The catch rates ranged from 0 to 82 kg/h. In the Gulf the maximum value was 6.8 kg/h in the B stratum close to the west coast of UAE, and also on the Iran coast of the Strait of Hormuz. Catch rates greater than 15 kg/h were observed in many substrata on the Iranian coast of the Gulf of Oman, particularly in substrata close to the border between Iran and Pakistan, where the highest catch rate of 96 kg/h was also observed. The Gulf of Oman appeared to be relatively richer in this resource than the Gulf on the basis of the sampling by the survey trawl gear.

(n) Pleuronectiformes (Flatfish, no figure) are not considered to be a valuable commercial species group at present, but interest in the exploitation of this group has been shown by Iran. Analysis of the catch rates showed the highest catch rate of 35 kg/h was on the Iranian side of Area 2. The rest of the Gulf area showed extremely poor catch rates. In the Gulf of Oman there were indications of relatively better catch rates on both sides than in the main body of the Gulf. The general catch rates from the Arabian side were particularly very poor.

(o) Some of the pelagic species such as Scombridae, Clupeidae and Engraulidae caught during the demersal survey did not contribute significantly to the catch composition, yet their catch data were analysed in order to obtain information which could be useful to the understanding of the pelagic resources.

Large Scombridae (tuna, bonitos and king mackerels (Fig. 1.21)) were mainly represented by king mackerels such as S. commerson and S. guttatus. Being primarily pelagic, this group is not effectively sampled by bottom trawl gear and it formed only 0.8 percent of the total catch. Examination of the catch rates for this group revealed that more than 17 kg/h was obtained in the 25-50 m depth range along the Iranian side of the Gulf. In the corresponding depth range on the Arabian side, the catch rates were lower (greater than 10 kg/h). In stratum A (10-25 m) and C (50-100 m) the catch rates were generally very low (greater than 10 kg/h) except in the substratum south of Bahrain (1A5) which showed a relatively higher value of 16 kg/h. It was also evident that the catches on the Iranian side and Shatt Al Arab consisted mainly of S. guttatus, whereas it was mainly S. commerson on the Arabian side of the Gulf and also the Gulf of Oman. The catch rates on the Arabian side of the Gulf showed a decreasing trend from east to west while it was fairly uniformly low all over the deepest part.

(p) Rastrelliger sp. (Indian mackerel) is a smaller member of the Scombridae and perhaps represented mainly by one species in the project area. The catch rate of this pelagic species was found to be evenly poor over the entire area, with catch rates ranging between 0-12 kg/h. The area north and east of Qatar appeared to show relatively higher concentrations of this group, with the highest catch of 12 kg/h in the substratum 2B3, northeast of Qatar. The low range of catch rates evenly distributed failed to bring out any clear differences in depthwise distribution.

(q) Clupeidae (Sardines (Fig. 1.22)) caught with the bottom trawl showed catch rates ranging between 0 and 113 kg/h. Catch rates of over 20 kg/h were observed in the 10-50 m depth range at the northwestern end of the Gulf, close to Shatt Al Arab, and also in the Strait of Hormuz. The catch rates for all substrata in the Gulf of Oman were relatively very poor. Substrata deeper than 50 m showed low catch rates in both Gulfs.

(r) Engraulidae (Anchovies). The members of this group are extremely small in size and generally tended to escape through the meshes of the trawl gear. The catch rates are extremely low or nil in almost all substrata except 1A1, 1A2 and 1B1, all close to the northwestern end of the Iran coast and the Shatt Al Arab area.

1.5.3 Seasonal Variation in Distribution

It can be expected that even localized seasonal migration of fish would influence the catch rates and the species composition in each substratum. Though it was originally planned to investigate such effects in the whole project area through repeated surveys, unforeseen circumstances prevented the implementation of this programme. Therefore, the survey results were examined for possible indications of any seasonal changes. For this purpose, substrata in which different parts were sampled during different seasons were selected. On the assumption that the catch rates and species composition in the different parts of the substratum should in the same season show approximately the same figures, clear differences might be interpreted as seasonal effects. Substrata 2B3/2B4 and 2C2/2C3 are adjacent to one another in the respective depth strata and both pairs with relatively large areas were identified as having been sampled in more than one season. Several differences were recorded between the part covered in different seasons. For instance, in the substrata 2B3/2B4 the groups Ariommidae and Lutjanidae showed a lower density in the part of the stratum covered in October-November than in the previous March-April, whereas the groups small Carangidae, large Carangidae and Pomadasydae showed the reverse trend (Table 1.4). In the deeper substrata 2C2/2C3, the groups more abundant in the part covered during the warm season included Synodontidae and small Carangidae. In the part covered during the cold season large Carangidae, Dasyatidae and Mullidae showed higher catch rates than in the other periods (Table 1.4).

Comparison of the results from these two groups of substrata suggests that some species like Synodontidae (mainly Saurida) and small Carangidae (especially Trachurus) move from shallow to deeper water in the warm season.

More detailed investigation of other substrata or strata show the same phenomenon. Whereas all differences could also be explained as permanent differences between parts of substrata, independent of seasonal effects, the suggestion is rather strong that they are due to seasonal variations if the opposite results of different depth zones are considered. Also the experience of commercial fisheries indicate seasonal changes in their catch composition.

Table 1.4

SEASONAL DIFFERENCES IN CATCH RATES (kg/h) IN SUBSTRATA 2B3+4 AND 2C2+3 (NUMBERS IN PARENTHESES REFER TO SPECIES IN PARENTHESES)

Substratum Season	2B3 + 4 Mar.-Apr.	2B3 + 4 May-June	2B3 + 4 Oct.-Nov.	2C2 + 3 Mar.-Apr.	2C2 + 3 May-July	2C2 + 3 Oct.
No. of trawl stations	12	16	34	45	54	13
Species group						
Ariidae	25	31	31	9	9	7
Ariommidae	15	1	-	31	100	43
Carangidae (Selaroides)	3(-)	20(12)	64(58)	3(-)	1(-)	1(-)
Small Carangidae	32	22	48	23	150	150
Carcharhinidae	12	23	10	6	5	8
Clupeidae	60	2	22	0	29	2
Dasyatidae	14	19	7	7	5	3
Gerreidae	4	7	12	1	0	-
Leiognathidae	2	2	6	6	1	-
Lethrinidae	75	19	167	0	1	-
Lutjanidae (L. malabaricus)	46(35)	18(17)	29(18)	14(10)	16(16)	4(4)
Mullidae (Upeneus sulphureus)	45(27)	20(8)	33(24)	32(30)	25(23)	22(22)
Nemipteridae (N. japonicus)	31(7)	21(2)	20(1)	13(13)	29(29)	11(10)
Pomadasyidae (Rhonciscus)	4(1)	16(12)	37(32)	2(-)	0(-)	1(-)
Serranidae (E. tauvina)	28(27)	26(26)	26(7)	2(1)	6(1)	0(-)
Sciaenidae	-	-	-	0	1	-
Sparidae	11	4	9	3	8	5
Sphyraenidae	16	1	14	1	0	11
Synodontidae	71	41	18	13	65	67
Theraponidae	0	7	29	3	-	-
Trichiuridae	-	-	0	1	0	1
Thenus orientalis	0	0	1	-	2	12
Mollusca	0	1	1	-	1	2
Crustacea	-	-	-	-	-	-
OTHERS	57	141	57	23	6	10
TOTAL CATCH RATE	551	442	597	193	402	356

Because most substrata have been sampled predominantly during one season only, and often neighbouring substrata in different seasons, the general picture of fish density and distribution may have been affected (Table 1.1B). Notwithstanding this, the distribution maps for most of the species show very clear distribution patterns, with little irregularities such as might be expected if migrations played a very considerable role.

Furthermore, the coverage of the various substrata depended on the availability of the research vessels and this did not show a clear systematic season distribution of the sampling. It is, therefore, believed that this phenomenon may have contributed to the variance of the estimates, but has had little effect on the total abundance estimates and the general distribution pattern of the species. Further, the coverage was accomplished over a period of about two years and hence the results obtained for the different seasons have not been from the same year.

Better information on seasonal migrations and seasonal variability would require a special research programme. Such information may also be derived from data on fishing grounds,catch size and composition from the commercial fleet.

1.5.4 Day-Night Variations

For determining the day-night variation in the catch rates, and consequently its influence on the estimate of the biomass, 88 night stations were allocated at random (Table 1.1A). The random distribution of these stations resulted in a variable number of stations in each substratum, ranging from 0 to 6 and an average of 2 night stations per substratum. Because of various unforeseen difficulties, only about 50 percent of the night stations were trawled in 9 substrata out of a total of 38 substrata. Therefore, for investigating the day-night variation, catch/h and the species composition (in percent) were calculated for an average of 4 day stations located adjacent to the night stations in each substrata, and compared with the results of the night stations. It was observed that in eight out of fourteen comparisons made, the catch rates were higher during the day than at night. Of the remaining 6 cases, 4 showed higher catch rates at night and the remaining 2 did not bring out noticeable differences (Table 1.5). Comparison of the overall mean values from the 14 comparisons gave 1.5 times higher catch rate for the day stations.

Frequency of occurrence of higher mean catch rates was greater in the daytime for stratum B but greater at nighttime for stratum A (Tables 1.5 and 1.6). Comparison of the catch rates for various species groups by the analysis of variance method showed that the daytime catch rates for Leiognathidae, Mullidae (Upeneus sp.) small Carangidae (Trachurus sp., Decapterus sp.) and Clupeidae were very significantly higher than the nighttime values. This should be anticipated in view of the fact that the above species groups are known to exhibit diurnal vertical migration, which would have contributed to the trend observed. Similar statistical analysis of the catches of Pomadasyidae and Synodontidae showed that the higher mean catch rate for nighttime (Table 1.6) was not significantly higher than that for daytime.

Considering the above results, it appears that there is a tendency for the bottom trawl catch rates to be higher in the daytime than at night but this difference becomes reduced when catches of pelagic species are disregarded. Even among the demersal species there are some which show significantly higher catch rates in the daytime, while others show only indications of an opposite trend. This pattern may not be a general one for all localities of the project area. However, in terms of the demersal species only, evaluations of the resources based mainly on the daytime sampling would not contribute to an underestimation of the biomass.

Table 1.5

COMPARISONS OF THE DAY-NIGHT VARIATION IN BOTTOM TRAWL CATCH RATES (kg/h)

Season	Substratum	No. of night stations	No. of day stations	Mean catch per hour at night (kg)	Mean catch per hour in daytime (kg)
December 1977	1A1	1	2	367	380
May 1977	1A2	1	5	421	247
March 1978	1A3	1	5	644	310
June 1978	1A3	1	2	199	150
April 1978	1B1	1	1	912	1 388
October 1978	1B1	5[1]	5[1]	328	710
May 1978	1B2	3	5	155	504
June 1978	1B2	3	9	188	548
March 1978	1C2	1	5	76	602
June 1978	1C2	1	5	143	194
July 1978	1C2	1	5	250	198
April 1978	2B1	1	5	675	1 332
April 1978	2C1	1	2	235	845
May 1978	3B1	1	5	934	951
Total/Average	9 substrata	17+5	56+5	394.8	597.0
Average, excluding pelagic species and Leiognathus				337.0	342.2

[1] Special day-night catch variation experimental fishing

1.5.5 Biological Information

Sampling for length composition, length weight relationship, gonad maturity, sex ratio and stomach contents, was carried out on the fish caught during the survey. Considering that a total of about 750 valid hauls were spread over 36 substrata, the number of samples from each substratum was not large and the large mixture of species in each haul, with evenly low representation by each species, also influenced the number of individuals of each species that were handled during the time interval between successive hauls. Further, on the basis of the availability of the vessels, samplings on the Arabian side and the central part of the survey area were made only between March and October for the combined years 1977/78. The substrata on the Iranian side were sampled mainly between October 1977 and April 1978 and, in the Gulf of Oman, the eastern half was covered in March 1977 and May 1978, while the rest was surveyed in August 1977 and 1978. Hence samplings from different parts of the survey area were not comparable.

Therefore, a proper analysis could not be attempted to bring out satisfactory results. However, all information and data collected have been systematically compiled (see Part 2 of this report). This could serve as a valuable working document for future biological studies to be undertaken by national and regional research laboratories in the various member countries. Some of the general findings, such as size ranges of the species observed during the survey, the main size ranges in the catches made, minimum size of mature fish and their spawning season as determined for the limited seasons of the observations in different substrata, are summarized in Tables 1.7 and 1.8.

Table 1.6

DAY-NIGHT VARIATION IN THE CATCH RATES (kg/h) OF VARIOUS SPECIES GROUPS IN DIFFERENT DEPTH STRATA

Substratum	1A	1A	1B+2B	1B+2B	1C+2C	1C+2C	3B1	3B1	Total	
No. of trawl stations	4	14	6	19	4	17	1	5	15	55
	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day
Species group										
Ariidae	60	34	29	38	34	18	16	22	35	29
Ariommidae	-	0	3	22	6	27	-	-	3	16
Carangidae	3	4	2	16	-	6	36	11	4	9
Small Carangidae	3	15	4	52	2	129	-	4	3	62
Carcharhinidae	-	9	4	20	3	11	-	31	2	15
Clupeidae	30	37	0	27	-	9	-	10	8	22
Dasyatidae	11	22	9	81	4	22	-	52	8	45
Gerreidae	2	0	3	3	-	-	0	3	2	2
Leiognathidae	3	12	5	120	1	4	-	7	3	46
Lethrinidae	18	3	0	2	-	-	-	1	5	2
Lutjanidae	2	1	3	4	5	5	-	0	3	4
Mullidae	94	31	26	52	17	50	0	29	40	44
Nemipteridae	8	8	17	27	22	10	62	62	18	20
Pomadasyidae	8	7	6	12	1	11	166	109	19	19
Rhonciscus	73	14	-	-	-	-	114	331	27	34
Serranidae	3	7	5	2	0	3	-	5	3	4
Sciaenidae	17	3	29	38	-	5	69	52	21	20
Sparidae	8	6	2	5	0	2	3	6	3	4
Sphyraenidae	2	4	0	5	0	5	-	14	1	6
Synodontidae	22	9	37	34	44	28	26	30	34	26
Theraponidae	6	4	20	29	1	16	-	0	10	16
Trichiuridae	9	11	-	5	1	2	-	84	3	13
Thenus orientalis	0	0	0	0	1	0	1	1	1	0
Mollusca	-	2	0	2	1	2	23	9	2	3
Crustacea	4	1	12	5	14	3	1	0	10	3
OTHERS	21	30	10	25	18	22	30	77	17	30
Total	408	275	223	628	176	392	546	951	281	494

Table 1.7

SUMMARY OF INFORMATION ON SIZE RANGE FOR VARIOUS SPECIES OBSERVED DURING THE DEMERSAL SURVEY

Species	Ns 1/	Ni	Observation period	Size-range (cm)	Main-range (cm)
Arius thalassinus	17		January-December	10-87	20-45
Ariomma indica	41		March-August	4-22	15-19
Decapterus kiliche	19		May-November	8-26	10-20
Selar crumenophthalmus	9		April-July/November	13-30	Same
Trachurus indicus	37		March-November	5-22	9-20
Selaroides leptolepis	18		March-October	7-16	8-14
Seriolina nigrofasciata		474	March-November	13-50	20-45
Chirocentris nudus		147	January-June	40-93	40-80
Lethrinus haematopterus	18		April-November	9-26	12-24
Lethrinus lentjan	21		April-November	11-39	12-27
Lethrinus miniatus	15		April-November	10-36	14-30
Lethrinus nebulosus		1 926	January-November	12-69	20-69
Lutjanus argentimaculatus		100	April-September	27-88	50-75
Lutjanus malabaricus		1 723	January-November	7-79 2/	20-75
Upeneus sulphureus	45		March-December	7-20	10-15
Nemipterus japonicus	49		March-December	5-35	10-25
Pomadasys argentea		122	January-May	23-60 2/	Same
Pomadasys maculatum		310	December-July	11-56	Same
Plectorhynchus pictus		642	January-November	12-75	Same
Rhonciscus stridens	9		March-September	8-19	Same
Rachycentron canadus		83	February-October	42-115 2/	70-100
Epinephelus aerolatus		46	March-July	10-50	20-40
Epinephelus sp.			March-October	56-98	Same
Epinephelus tauvina		839	January-November	23-98	30-80
Argyrops spinifer		747	March-October	7-77	10-30
Saurida tumbil	9		March-July	7-49	Same
Saurida undosquamis	30		March-November	4-45	Same

1/ Ns = number of samples
Ni = number of individual specimens

2/ Sizes larger in the Gulf of Oman (Area 3)

1.5.6 Biomass Estimates

As already explained in the section dealing with the methods of analysis, the biomass of the demersal fish in a substratum was obtained by multiplying the mean density of fish per square kilometre by the size of the substratum in square kilometres. Such estimates for the substrata have been combined to form the estimates for Areas 1, 2 and 3 and then for the whole project area.

The total biomass of fish estimated from the bottom trawl catches is given in a simple form in Table 1.9. The biomass estimates for Areas 1 and 2 of the Gulf were 416 000 t and 526 000 t respectively, which makes in total 942 000 t for the Gulf and 174 000 t for the Gulf of Oman, giving a total of about 1 117 000 t for the project area.

Table 1.8

SUMMARY OF INFORMATION ON MATURITY AND SPAWNING IN A NUMBER OF SPECIES CAUGHT

Species	No. of fish	Observation period	Observed spawning period	Minimum size at maturity as observed (cm)
Arius thalassinus	134	March-June	March-June	35
Ariomma indica	251	March-July	March-July	16
Decapterus kiliche	78	April-July	April-July	16.5
Selar crumenophthalmus	102	April-June	June	-
Trachurus indicus	338	March-November	March-May	15
Seriolina nigrofasciata	101	March-July	March-July	38
Chirocentrus nudus	125	March-June	April	40
Lethrinus lentjan	55	June-July	July	21
Lethrinus nebulosus	384	January-November	April	34
Lutjanus argentimaculatus	94	April-May	April	54
Lutjanus malabaricus	833	January-November	April-June	61
Upeneus sulphureus	165	March-May	May	8
Nemipterus japonicus	324	December-June	March-June	14
Pomadasys maculatum	97	December-May	April	40
Plectorhynchus pictus	97	March-November	June	39
Rhonciscus stridens	80	March	March	10
Epinephelus aerolatus	32	April-July	April	-
Epinephelus tauvina	304	March-October	March-May	51
Argyrops spinifer	165	March-June/Oct.	March-April	-
Saurida tumbil	143	March-July	March-July	23
Saurida undosquamis	380	March-July	March	17

As described before, the trawl catches contained a significant amount of pelagic species. Whereas these species would contribute to the economy of a trawl fishery, it cannot be expected that the standard trawl has caught these species with the same efficiency as demersal species. Part of the pelagic fish would have escaped the trawl, particularly if the fish were swimming above the level sampled by the trawl net. Thus the demersal survey data will provide only an estimate of the biomass for the pelagic fish which was present at the water level sampled by the gear and, therefore, provide only a minimum estimate. The pelagic survey carried out by the project, on the other hand, had been set up to estimate the total pelagic stocks (Sivasubramaniam *et al.*, 1981). Hence this report will concentrate on the demersal resources but some tables will also include data for pelagic fish for comparison with the acoustic survey results. Subtracting the pelagic species from the trawl catches, the total biomass in the Gulf of all the demersal species was estimated as 948 000 t. Of this, the estimated biomass of the noncommercial species among the demersal stocks was about 397 000 t. Thus, the estimate of the total biomass of the commercial demersal species was approximately 550 000 t (Table 1.9).

Table 1.9

ESTIMATED BIOMASS OF THE TOTAL DEMERSAL SPECIES GROUPS AND PELAGIC GROUPS CAUGHT BY TRAWL BY AREA

Species groups	Area 1 (88 278 km^2)	Area 2 (107 468 km^2)	Area 3 (31 442 km^2)	Total (227 188 km^2)
All groups	416 000	526 000	174 000	1 117 000
All pelagic species	70 000	91 000	8 000	169 999
All demersal species	346 000	435 000	166 000	948 000
All commercial demersal	195 000	254 000	100 000	550 000
Nemipteridae	16 000	40 000	38 000	94 000
Mullidae	48 000	36 000	4 000	88 000
Ariommidae	30 000	39 000	0	69 000
Pomadasyidae	12 000	13 000	16 000	41 000
Lethrinidae	5 000	24 000	7 000	36 000
Carcharhinidae	15 000	17 000	2 000	34 000
Lutjanidae	9 000	15 000	2 000	26 000
Serranidae	4 000	9 000	2 000	15 000
Sepiolidae	1 000	1 000	6 000	8 000
Pleuronectiformes	1 000	3 000	2 000	6 000
Crustacea	1 000	1 000	-	2 000
All noncommercial demersal	151 000	181 000	65 000	397 000
Leiognathidae	90 000	30 000	5 000	125 000
Synodontidae	24 000	53 000	8 000	85 000
Ariidae	24 000	20 000	2 000	46 000
Gerreidae	2 000	2 000	6 000	10 000

A further discussion of the biomass estimates and potential yield is given in Part 4 of this report.

In view of the differences in distribution of the species and the basic delineation of the survey area that is likely to be followed for the exploitation of the resources by Iran and the Arabian countries bordering the two Gulfs, it is considered useful to estimate the abundance of the demersal species in the 10-50 m depth ranges on the Iranian (northern) and Arabian (southern) sides of the project area. In the absence of national boundaries for the exploitation of living resources of the two Gulfs, no national subdivision is possible at present.

However, species compositions in percentages of the total catch are given for every substratum together with the biomass estimates for each substratum in Table 1.11. This permits estimation of abundance and catch composition for various possible combinations of substrata to be exploited by any member country. Biomass estimates by depth range and area are given in Table 1.10. The estimated total biomass of all demersal species in the depth range of 10-50 m along the entire Iranian side, Shatt Al Arab area (substrata 1A2 and 1B2) and along the entire Arabian side of the project area were 200 000 t, 110 000 t

Table 1.11

ESTIMATED BIOMASS OF ALL SPECIES CAUGHT IN THE VARIOUS SUBSTRATA

Area	Substrata	Total biomass (t)	Area	Substrata	Total biomass (t)
1	1A1	30 783	3	3B1	10 728
	1A2	21 826		3B2	7 041
	1A3	32 608		3B3	1 241
	1A4	12 291		3B4	12 235
	1A5	6 983		3B5	19 760
	1B1	103 115		3C1	5 196
	1B2	106 825		3C2	5 726
	1B3	27 318		3C3	8 361
	1C1	25 765		3C4	31 552
	1C2	49 329		3D1	11 998
	Sub-total	416 844		3D2	1 453
2	2A1	54 284		3D3	28 999
	2A2	66 268		3E1	6 076
	2A3	13 550		3E2	9 320
	2(A)B1	34 157		3E3 1/	6 774
	2(A)B2	45 795		3E4	5 671
	2B3	59 640		3E5 1/	1 918
	2B4	52 364		Sub-total	174 058
	2B5	15 941			
	2C1	59 060			
	2C2	104 075	Gulf	Total (Ar.1+2)	1 054 550
	2C3	21 330	Gulf of Oman	(Area 3)	174 058
	Sub-total	526 465		Grand total	1 228 608 t
1 and 2	Excluded area	111 241			
Gulf	Total	1 054 550			

1/ Substrata without any valid hauls. Biomass estimates based on results from adjacent substrata

Table 1.12A

PERCENTAGE SPECIES COMPOSITION BY SUBSTRATA

Substratum	1A1	1A2	1A3	1A4	1A5	1B1	1B2	1B3	1C1	1C2	2A1	2A2
No. of station	19	16	16	19	7	37	84	19	47	82	14	19
Ariidae	12	16	1	1	1	4	6	2	1	4	2	3
Ariommidae			0			1	7	1	29	24		0
Carangidae	13	1	0	1	8	3	1	1	1	0	1	
Decapterus		0	1			2	3	6	1	3	1	1
Carangoides sp.	1	1	0	0		2	0	0	0	0	0	0
Selar sp.	0		0	1		2	0	1	1	1	0	2
Selaroides sp.	1	1	0	39	5	0	0	3		1	10	8
Trachurus sp.	0		5	1		2	8	17	22	22	0	1
Mixed small Carangidae						3	2	0			0	
Carcharhinidae	3	8	4	3		3	6	2	1	4	4	6
Clupeidae	3	8	11	3	1				0	0	1	0
Dasyatidae	1		0	3	3	2	1	4	0	4	15	2
Gerreidae	0	0	0	5	4	1	1	1		0	4	1
Leiognathidae	21	28	2	0	0	37	30	5	0	3	1	1
Lethrinus sp.			0	4	0		0	1			11	10
Lethrinus lent.			0	6	0		0	4			2	3
Lethrinus neb.	0	0	1	3	0		1	1	0		1	4
Lutjanidae												0
Lutjanus sp.		0	0		0	0	1	8	0	0	1	1
Lutjanus erth.	0		1	0		1	3	4	2	1	0	0
Mullidae								0				1
Mulloidichthys	7					5						0
Parupeneus sp.			0	5	0		0	2	0	0	2	2
Upeneus sp.	1	3	43	1	0	4	8	4	16	12	2	4
Nemipteridae			1	1				1	0	0	1	0
Nemipterus sp.	1		0	0	1	1	0	0	2	0	1	1
Nemipterus jap.	3	0	2			5	3	2	3	3		
Pomacentridae				1				0			0	2
Pomadasyidae			0	1	0	0	1	0		0	3	4
Pomadasys sp.	5	2	0		0	1	0	0	0	0		0
Rhonciscus	1	1	15	5		0	1	7	0		5	0
Serranidae				0				0	0			
Epinephelus sp.			0	0		0	0	0	2	1	0	0
Epinephelus tauv.	0	1	2	2	10	0	1	3	1	0	3	3
Scianidae	3		1			0	0			0		
Sparidae	0	0	2	2	1	0	1	6	1	1	1	1
Sphyraena sp.	1		2	0	3	2	1	3	2	1	1	7
Synodontidae	0	0					0		0	0	0	0
Saurida sp.	2	1	0			3	0					8
Saurida tumbil	0		2			0	2	0	2	2		0
Saurida undosq.	0		0	1		3	4	3	7	6		8
Theraponidae	1	0		1	0	3	2	0	0	0	2	2
Trichiuridae	1	12	0			0	0	0		0		
Molluscus	0	1	0	0		0	0	0	0	0	0	0
Thenus orientalis	0		0	0		0	0	0	1	0	0	1
Other crustacea	2		0			0	0	0	0	0		
Others	17	16	4	10	52	10	6	8	5	8	25	10

Table 1.12B

PERCENTAGE SPECIES COMPOSITION BY SUBSTRATA

Substratum	2A3	2B1	2B2	2B3	2B4	2B5	2C1	2C2	2C3	3B1	3B2	3B3
No. of station	8	13	15	50	17	6	6	63	58	2	4	1
Ariidae	2	3	5	5	5	2	4	3	4	2	0	4
Ariommidae		0	0	1	0	0	0	23	16			
Carangidae		4	4	1	1	1	8	1	1	4	2	16
Decapterus sp.	11	0	4	3	3			1	2	1		
Carangoides sp.	0	0	1	0	0	1	3	0	0	2	3	11
Selar sp.			0	5	1		1	3	1		0	
Selaroides sp.	4		0	8	7	0		1		0		
Trachurus sp.	0		0	0	2			22	19			
Mixed small Carangidae				2	4	9		0	0			
Carcharhinidae	4	3	2	4	2	9	5	2	3	4	0	
Clupeidae	5	4	2	14	1	0	1	1	1	0		
Dasyatidae	7	17	5	2	2	4	2	2	2	7	4	
Gerreidae	0	2	0	1	2	0		0	0	4	2	0
Leiognathidae		20	26	2	1		1	0	3	1	16	1
Lethrinus sp.	5			2	7	6		0	0			
Lethrinus lent.	4		0	5	11	0		0	0			
Lethrinus neb.	2		0	2	3	3		0	0	0		
Lutjanidae												
Lutjanus sp.	0	0	0	1	2	4		0	1			
Lutjanus erth.		0	3	5	2	4	1	2	7			1
Mullidae	0							1	0			
Mulloidichthys	4				1	4		2				
Parupeneus sp.				3	2				0			
Upeneus sp.	2	4	13	3	4	6	3	4	14	2	19	2
Nemipteridae	19	0	0	1	1	3		0	0			
Nemipterus sp.	8	0	0	1	2	15		4	0		1	
Nemipterus jap.		5	8	1	2		31	4	4	13	14	6
Pomacentridae	6			0	1	1			0			
Pomadasyidae	0		0	0	0	2		0	0			
Pomadasys sp.		2	1		1	2	6	0	0	7	6	9
Rhonciscus				6	0					21	0	1
Serranidae				0								
Epinephelus sp.	1		0	0	2	0		0	2	0	0	
Epinephelus tauv.		0	0	4	2	3	1	0	1	0		4
Sciaenidae		6	0				1	0	0	4	0	
Sparidae	1	0	1	2	1	1		1	3	3	0	1
Sphyraene sp.	0	1	11	2	3	1	2	1	1	1	14	
Synodontidae									0			
Saurida sp.	8			0	6	5	3	10	1	1	11	31
Saurida tumbil		9	5	0	1	2	0	3	3	3	1	
Saurida undosq.		3	1	1	2	4	0	3	3			
Theraponidae		3	2	1	2		5	1	0	0		1
Trichiuridae		1	0	0	0		17	0	0	5	0	1
Cephalopods	0	1	0	0	0	1	0	0	1	3	1	1
Thenus orientalis	1	0	0	0	0	0		1	0	0	0	
Other Crustacea		0	0					0	0	1		
Others	7	11	7	11	9	7	6	4	6	10	6	10

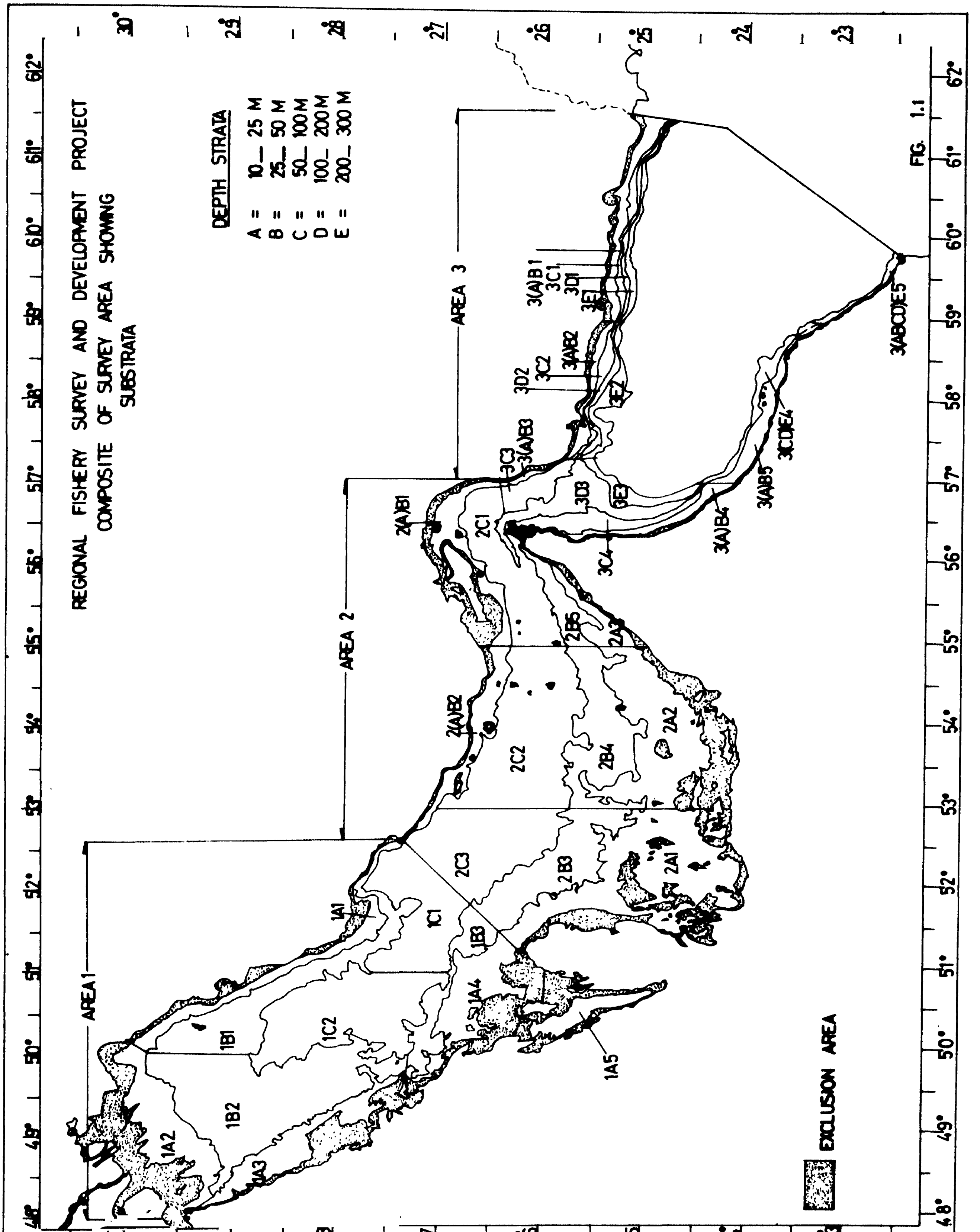
Table 1.12C

PERCENTAGE SPECIES COMPOSITION BY SUBSTRATA

Substratum	3B4	3B5	3C1	3C2	3C3	3C4	3D1	3D2	3D3	3E1	3E2	3E4
No. of station	1	15	1	5	2	3	2	2	3	2	2	7
Ariidae	3	1	0		3	1	0		1			0
Ariommidae		[redacted]	0	0	0	0			0			
Carangidae	8	1	5	0	3	1	2	1		0		2
Decapterus sp.	0	0	1	0	0	4	4		2			
Carangoides sp.	8	2	0		8	5	1		11			9
Selar sp.				30	0		0		2			
Selaroides sp.												
Trachurus sp.												
Mixed small Carangidae												
Carcharhinidae	2	0	2	1	3	3	1	0	2	5	2	2
Clupeidae		0	2									
Dasyatidae	0	6	2	1	1		1		0			6
Gerreidae	0	18	0			0						1
Leiognathidae	5	11			1	0						0
Lethrinus sp.	9	15										9
Lethrinus lent.	1	0				0						0
Lethrinus neb.	0	3										
Lutjanidae	4	0										
Lutjanus sp.	6	2	0			0						3
Lutjanus erth.		1			2				4			
Mullidae												
Mulloidichrhys		2										0
Parupeneus sp.	1	0		1		0						
Upeneus sp.		4	0		4	0						
Nemipteridae	0	0										0
Nemipterus sp.	7	5		5		6		58	33	23	33	30
Nemipterus jap.		0	30	29	19	5	58	1	18			
Pomacentridae												
Pomadasyidae	1	4										0
Pomadasys sp.	0	2	2	0	8	0			15			3
Rhonciscus			19		0	45	0					
Serranidae		1									2	
Epinephelus sp.	4	0	2	1		0	1		0	1		11
Epinephelus tauv.		0	1	0	0				1			1
Sciaenidae					1		1			3	21	
Sparidae	2	1	2	2	0	2			3			6
Sphyraena sp.	2	2	3		0	1				0		0
Synodontidae		0			7			10				
Saurida sp.		0	1	0			1		2	2	1	
Saurida tumbil	3	6	2	4		2	1					8
Saurida undosq.												
Theraponidae	0	0	0		1							
Trichiuridae	21	0	9	6	4	24	6	1	4		1	3
Molluscs	0	1	7	11	1	0		21	1	14	8	1
Thenus orientalis	0	0	1	0			7					
Other crustacea		0			0	0					0	
Others	12	12	9	6	34	1	16	8	1	52	32	5

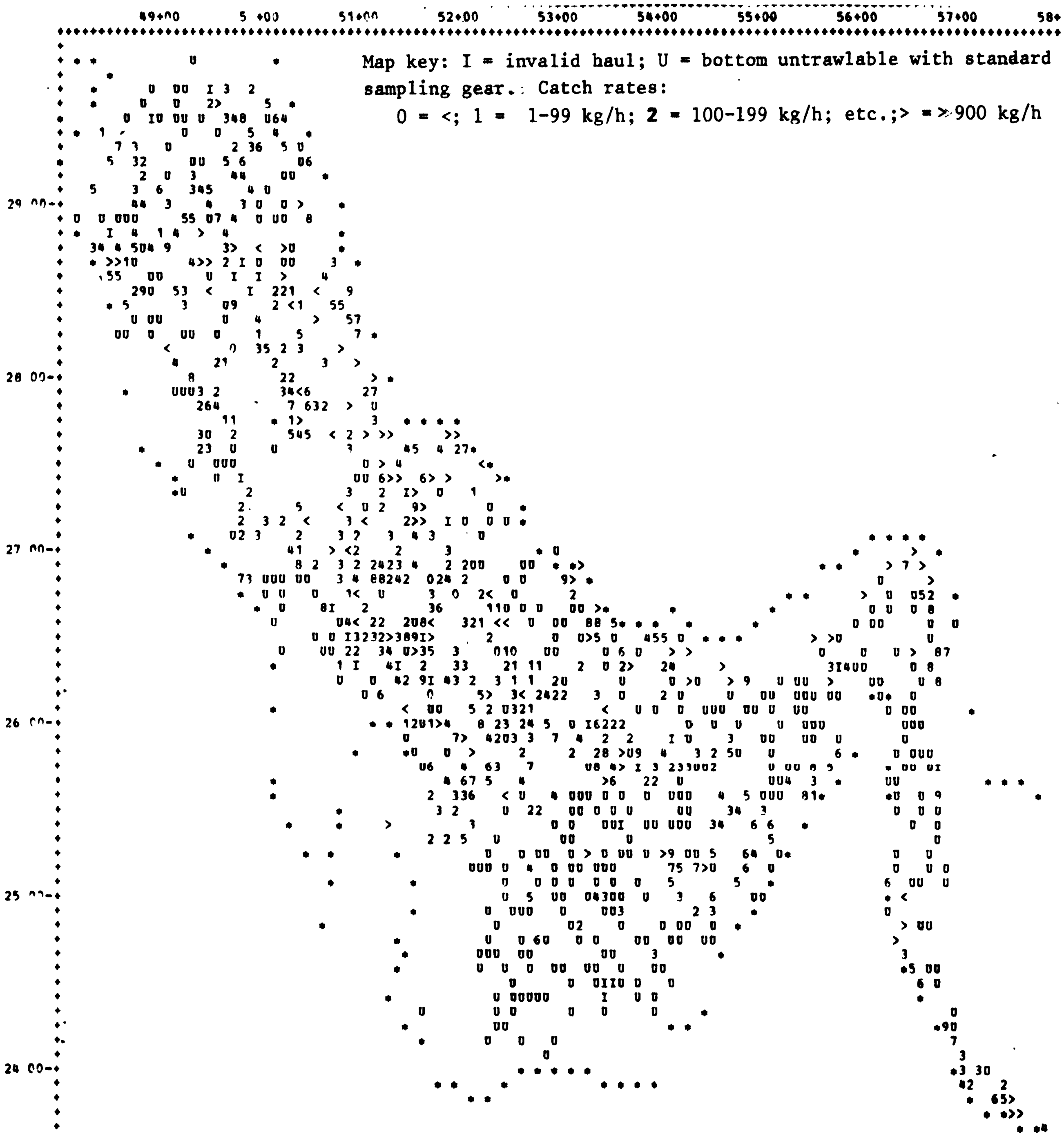
The substrata adjacent to the main concentrations of the excluded area showed that the biomass of the commercial species groups was about 47 percent of the total biomass, and if the same percentage is applied to the excluded area then the estimated biomass values for commercial and noncommercial groups would be about 52 000 and 59 000 t, respectively.

This raised the biomass estimates of all demersal, the commercial demersal and the noncommercial dimersal groups to 1 600 000 t, 600 000 t and 456 000 t, respectively (Table 1.10)



REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
COMPOSITE OF SURVEY AREA SHOWING
SUBSTRATA

FIG. 1.1



Map key: I = invalid haul; U = bottom untrawlable with standard sampling gear. Catch rates:
0 = <; 1 = 1-99 kg/h; 2 = 100-199 kg/h; etc.;> = >900 kg/h

Fig. 1.2 Randomly selected stations station as covered after 54 cruises

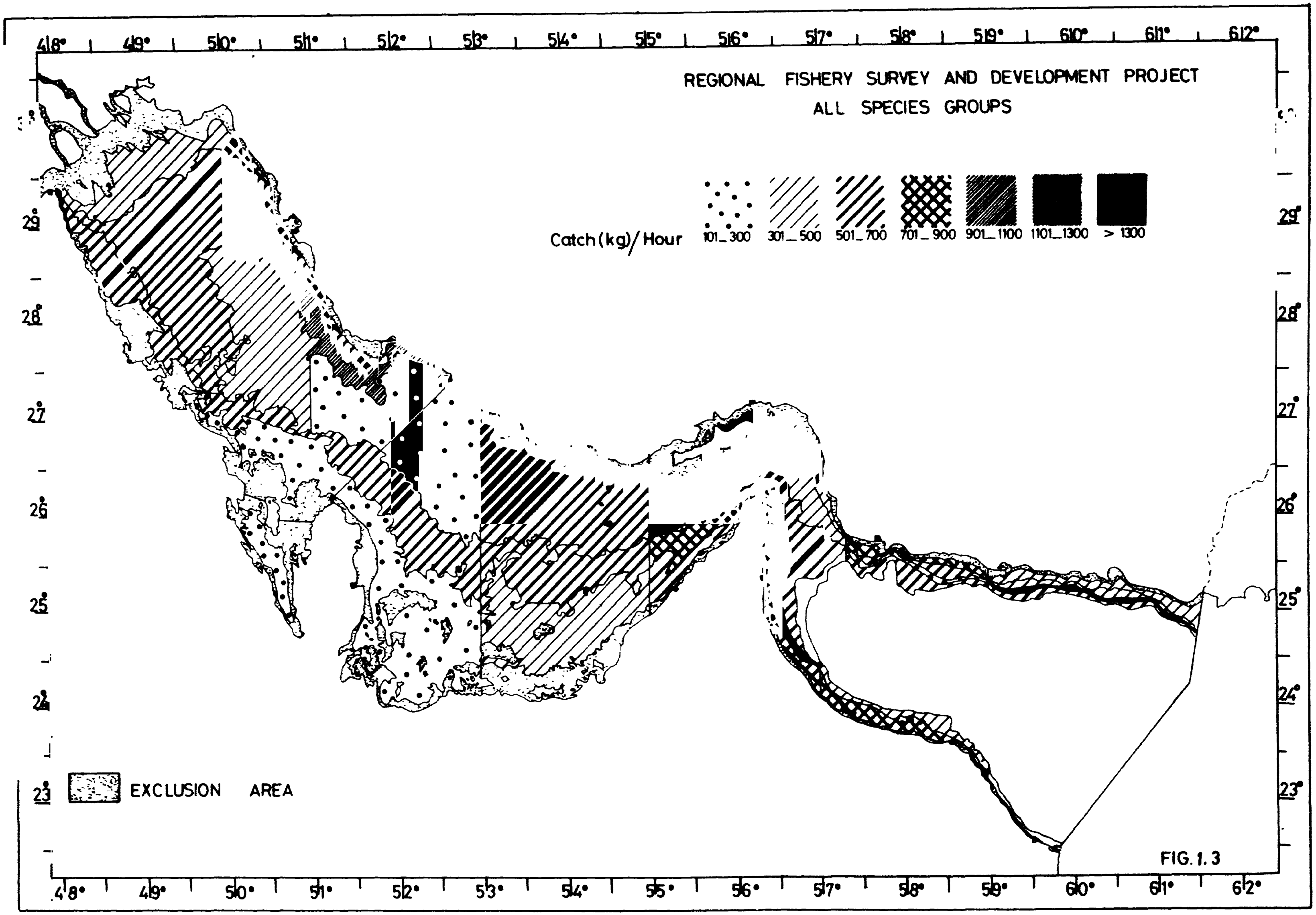

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
ALL SPECIES GROUPS
Catch (kg)/ Hour
101_300
301_500
501_700
701_900
901_1100
1101_1300
> 1300
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
29°
28°
27°
26°
25°
24°
23°

FIG. 1.3

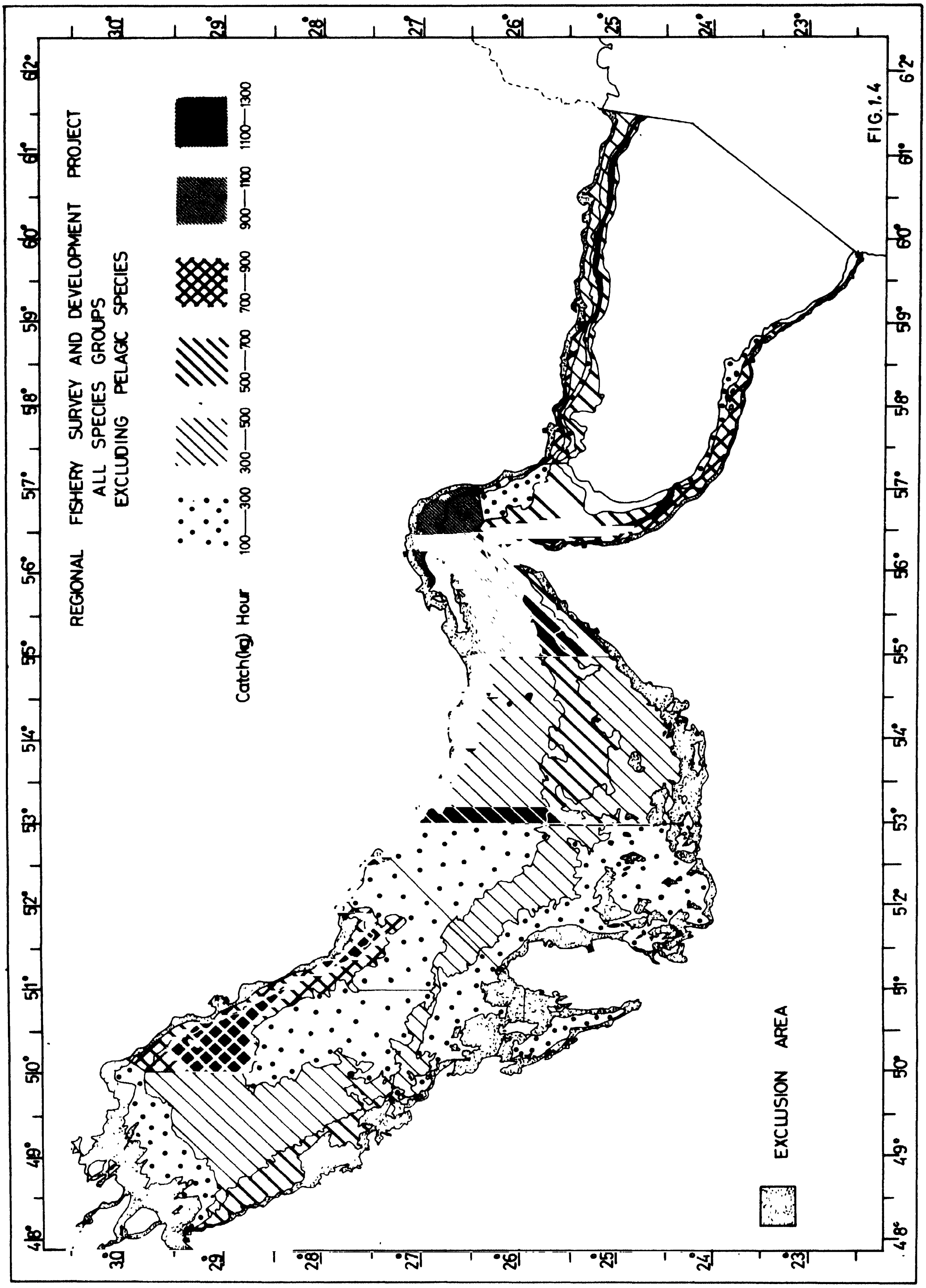

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
ALL SPECIES GROUPS
EXCLUDING PELAGIC SPECIES
Catch(kg) Hour
100—300
300—500
500—700
700—900
900—1100
1100—1300
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
30°
29°
28°
27°
26°
25°
24°
23°

FIG.1.4

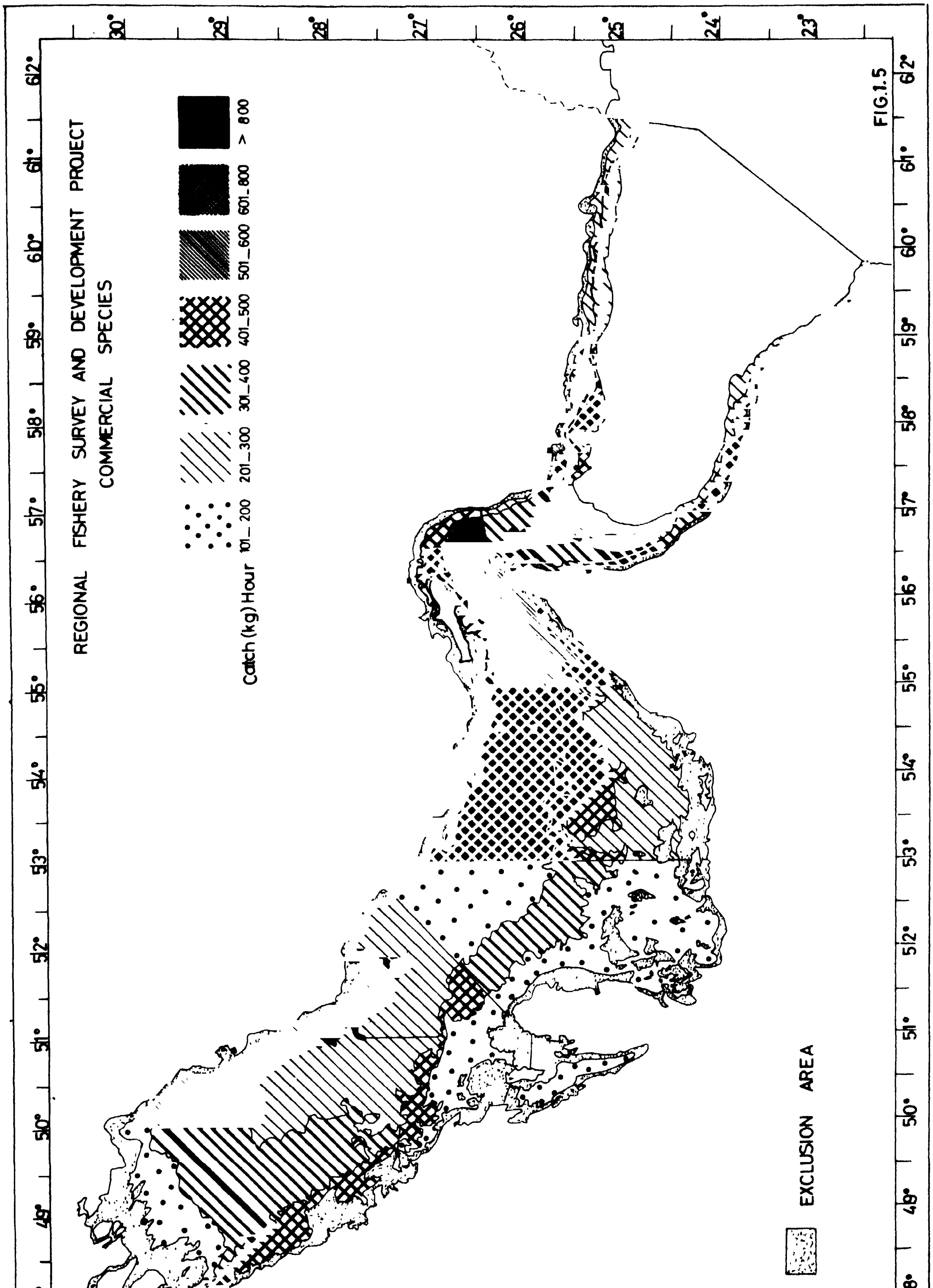

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
COMMERCIAL SPECIES

FIG.1.5

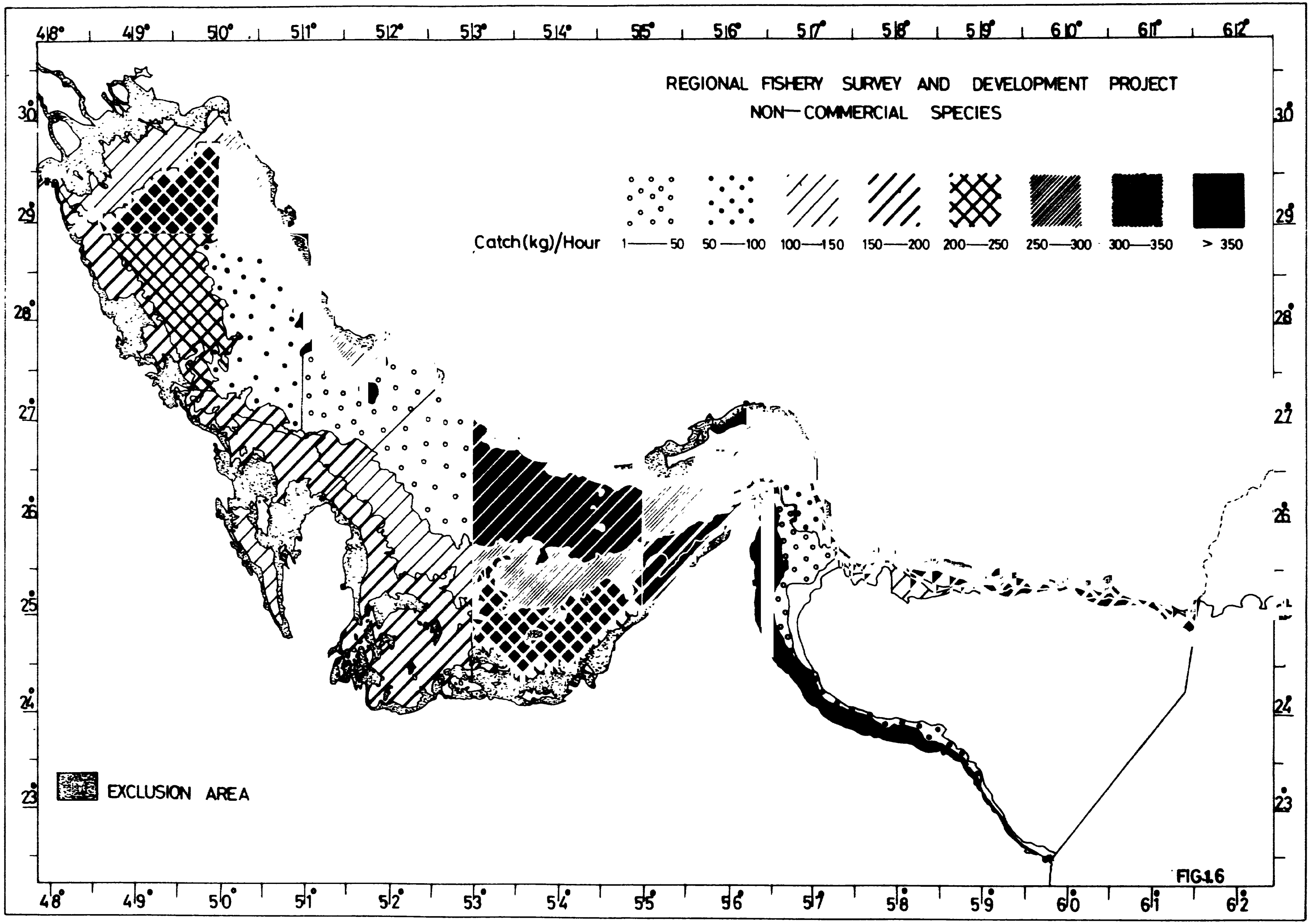

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
NON—COMMERCIAL SPECIES
Catch(kg)/Hour
1——50
50——100
100——150
150——200
200——250
250——300
300——350
> 350
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
30°
29°
28°
27°
26°
25°
24°
23°

FIG.16

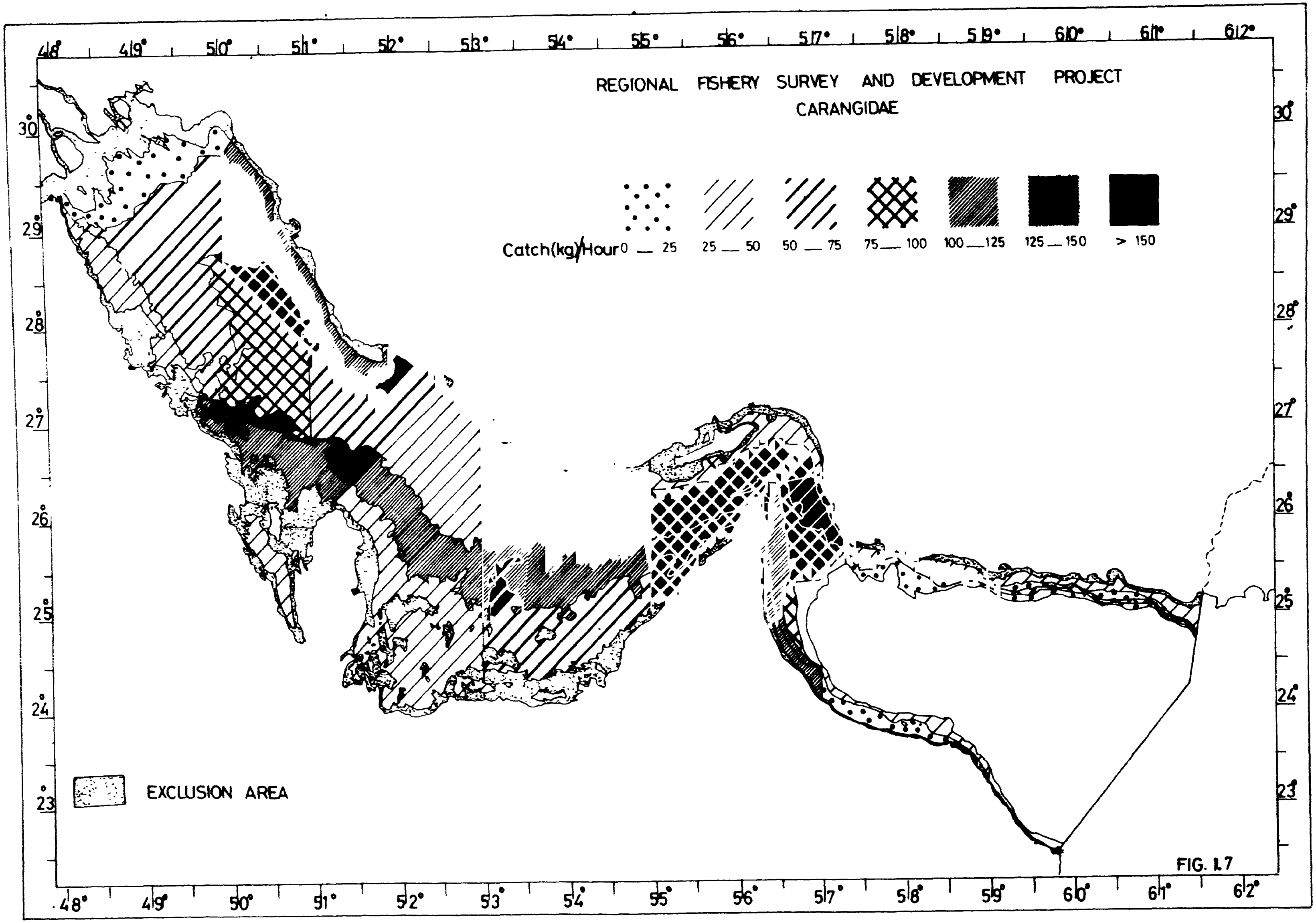
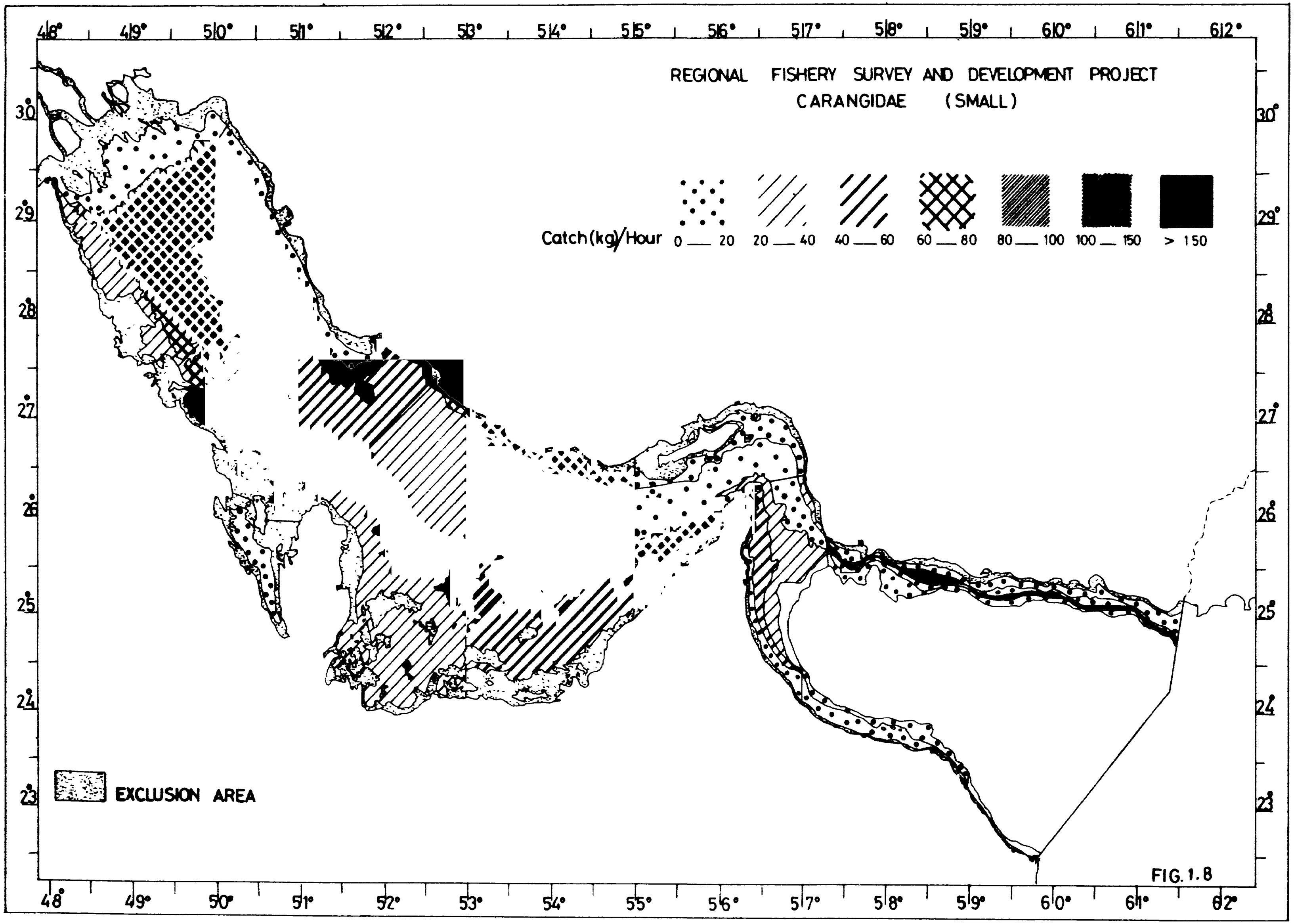

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
CARANGIDAE
Catch(kg)/Hour
0 — 25
25 — 50
50 — 75
75 — 100
100 — 125
125 — 150
> 150
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
30°
29°
28°
27°
26°
25°
24°
23°

FIG. 1.7



REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
CARANGIDAE (SMALL)

FIG. 1.8

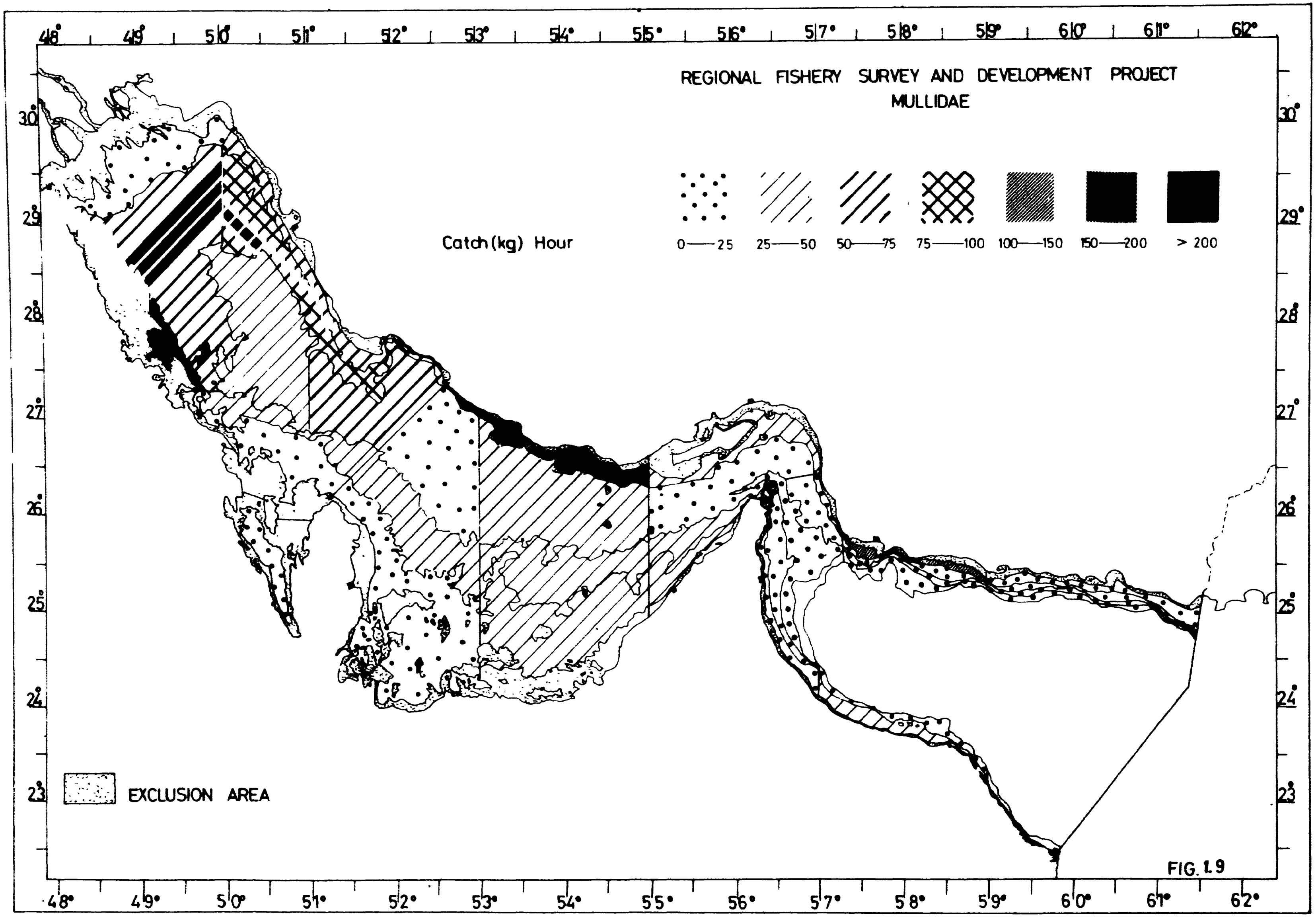
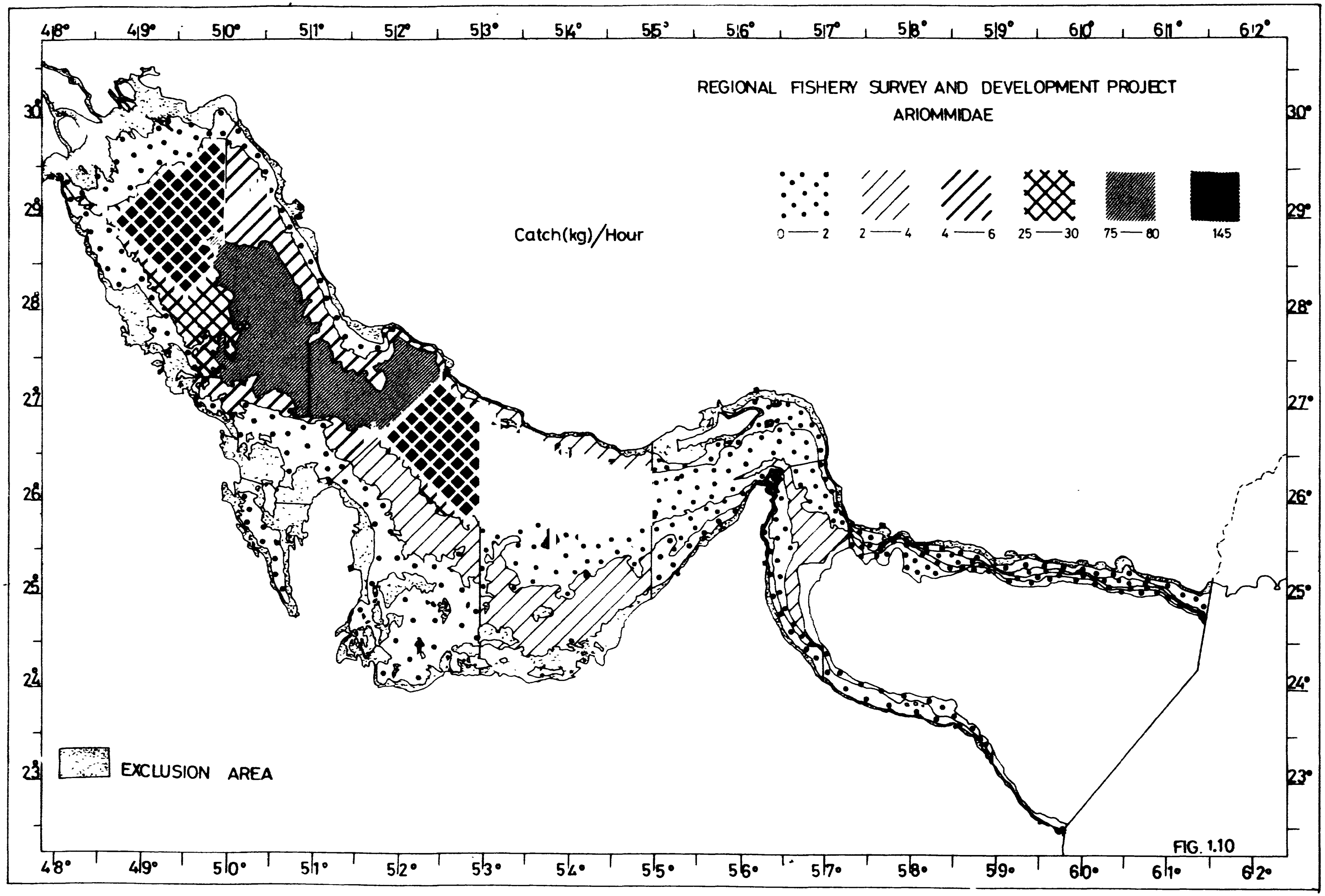

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
MULLIDAE
Catch (kg) Hour
0——25
25——50
50——75
75——100
100——150
150——200
> 200
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
30°
29°
28°
27°
26°
25°
24°
23°

FIG. 1.9



REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
ARIOMMIDAE

FIG. 1.10

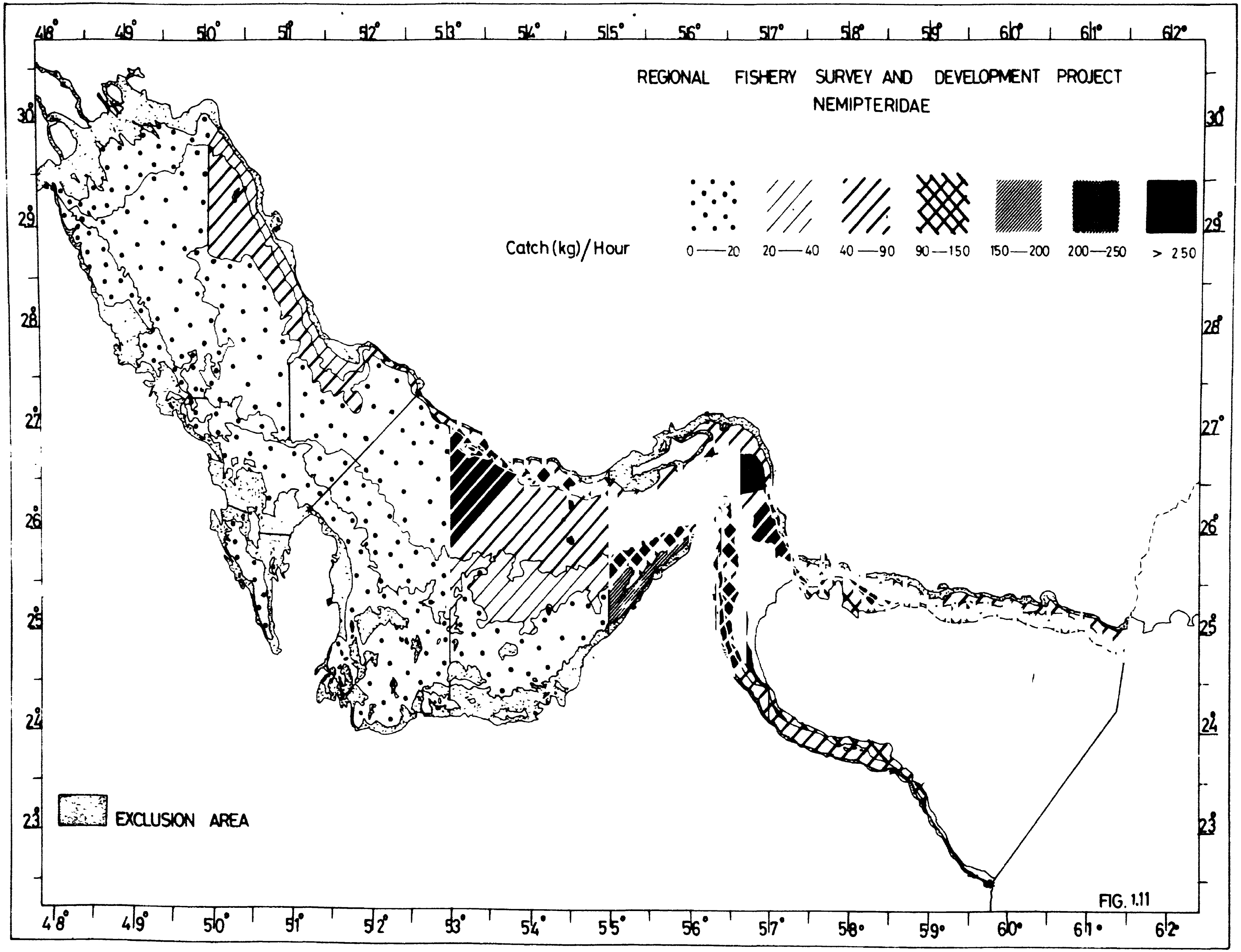
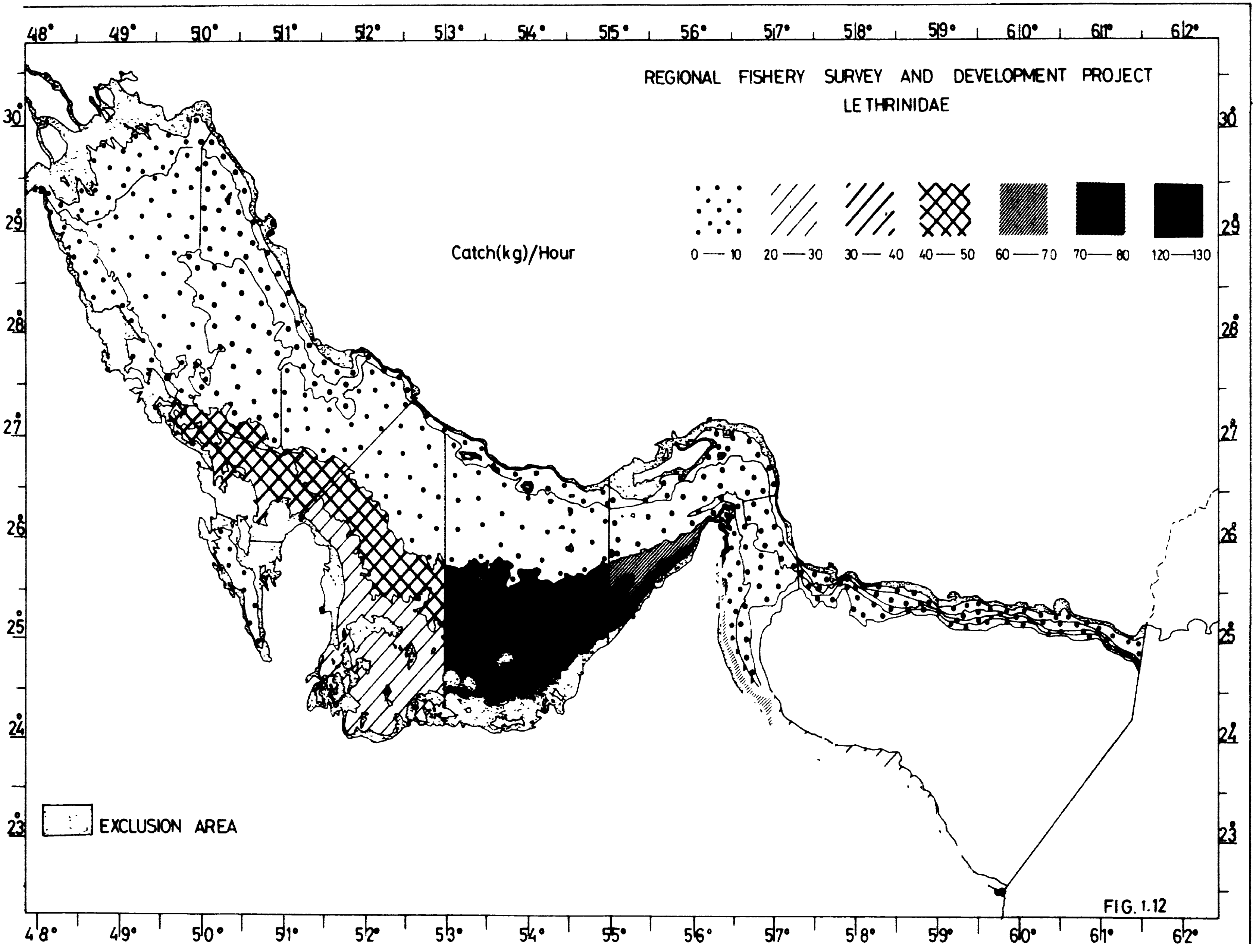

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
NEMIPTERIDAE
Catch (kg)/Hour
0—20
20—40
40—90
90—150
150—200
200—250
> 250
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
30°
29°
28°
27°
26°
25°
24°
23°

FIG. 1.11



REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
LETHRINIDAE

FIG. 1.12

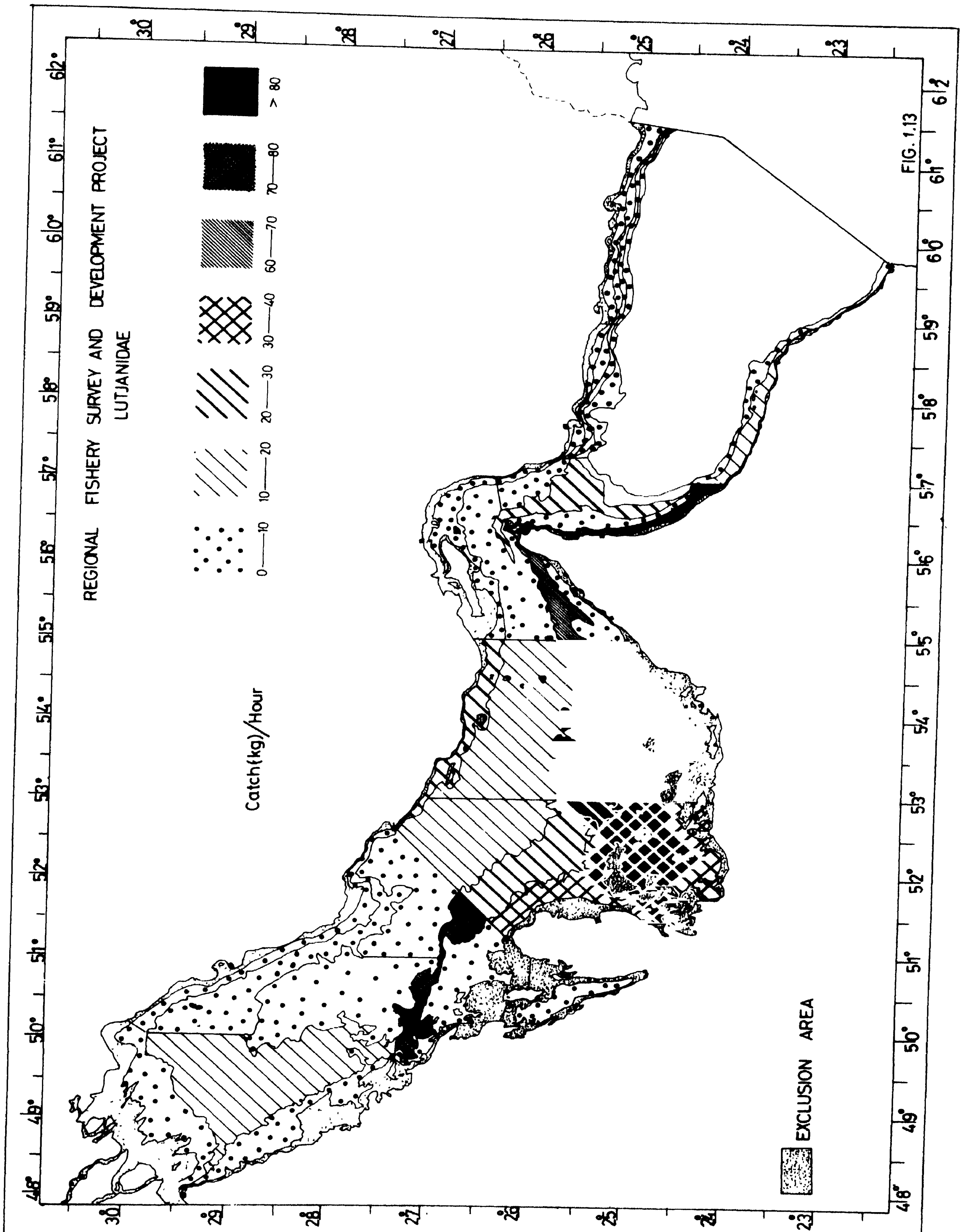

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
LUTJANIDAE
Catch(kg)/Hour
0—10
10—20
20—30
30—40
60—70
70—80
> 80
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG. 1.13

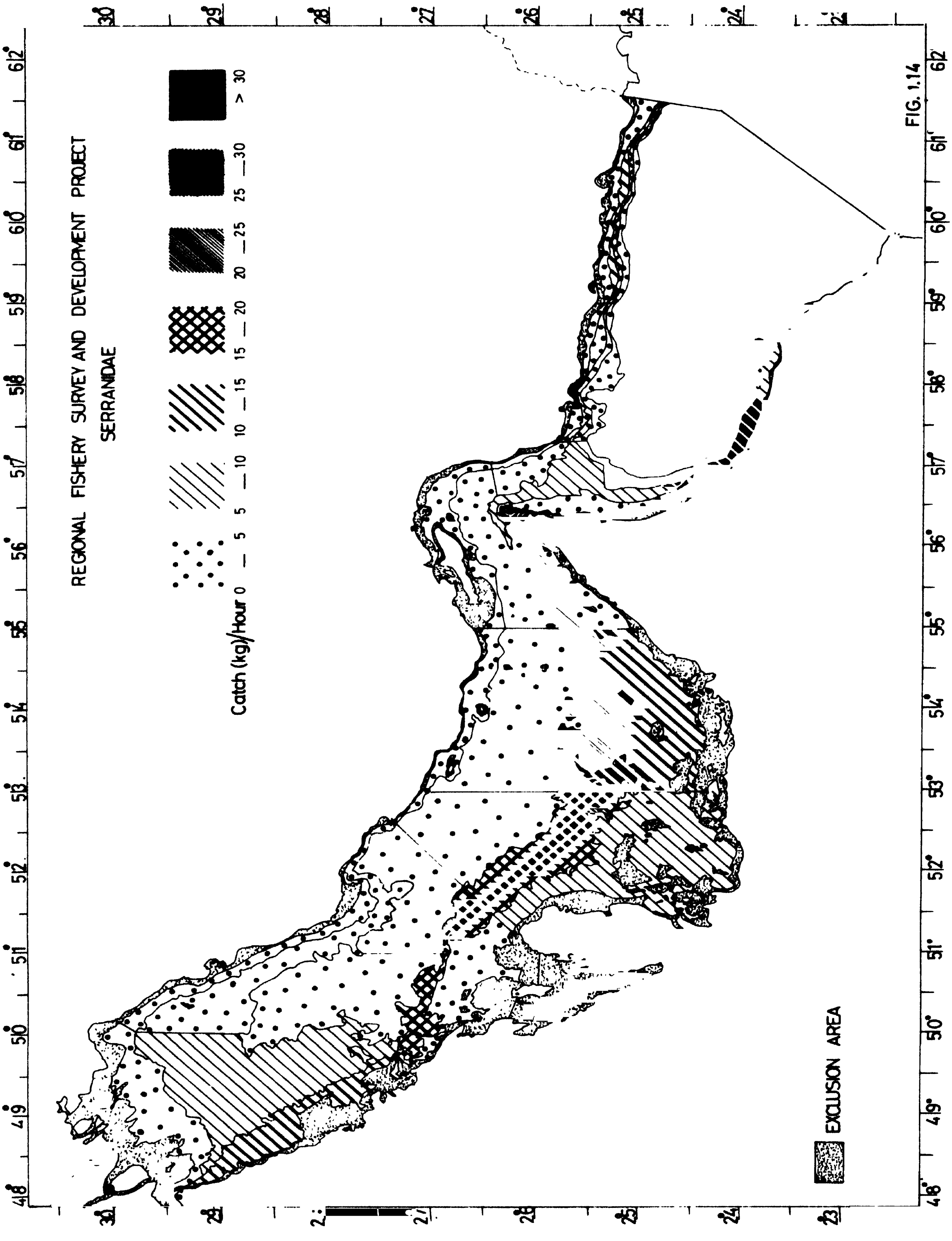

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
SERRANIDAE
Catch (kg)/Hour
0 — 5
5 — 10
10 — 15
15 — 20
20 — 25
25 — 30
> 30
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG. 1.14

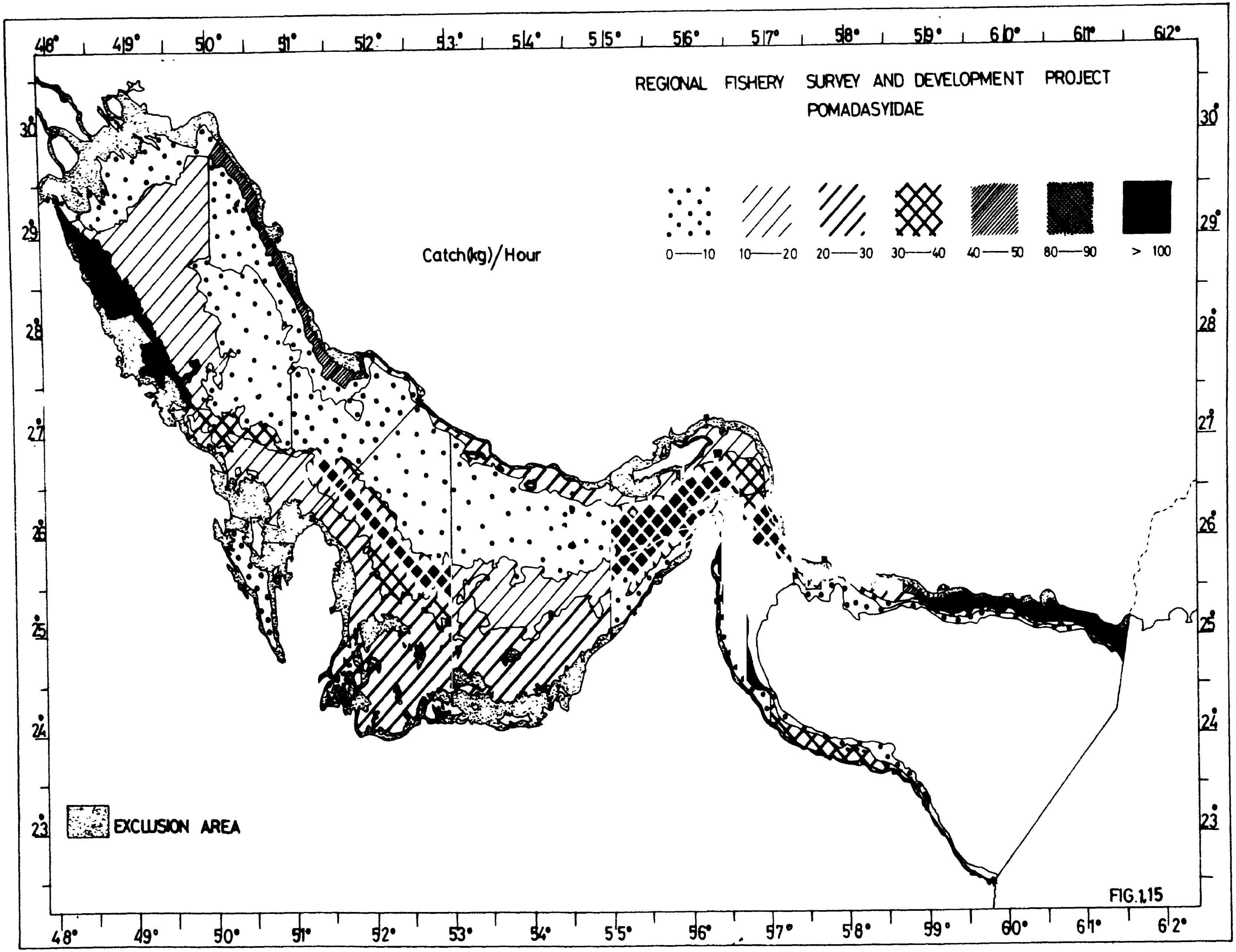

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
POMADASYIDAE
Catch(kg)/Hour
0—10
10—20
20—30
30—40
40—50
80—90
> 100
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
30°
29°
28°
27°
26°
25°
24°
23°

FIG.1.15

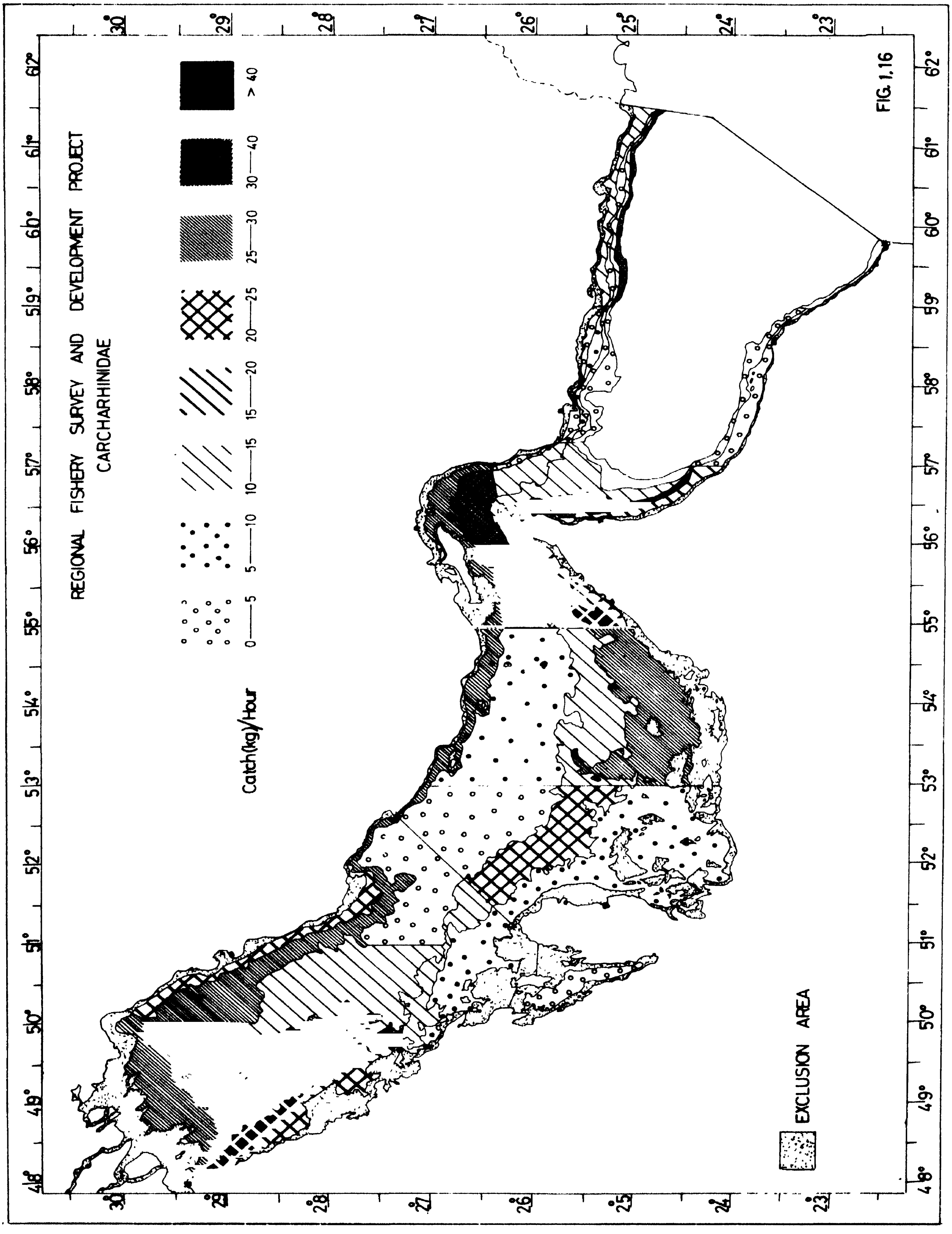

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
CARCHARHINIDAE
Catch(kg)/Hour
0—5
5—10
10—15
15—20
20—25
25—30
30—40
> 40
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG. 1.16

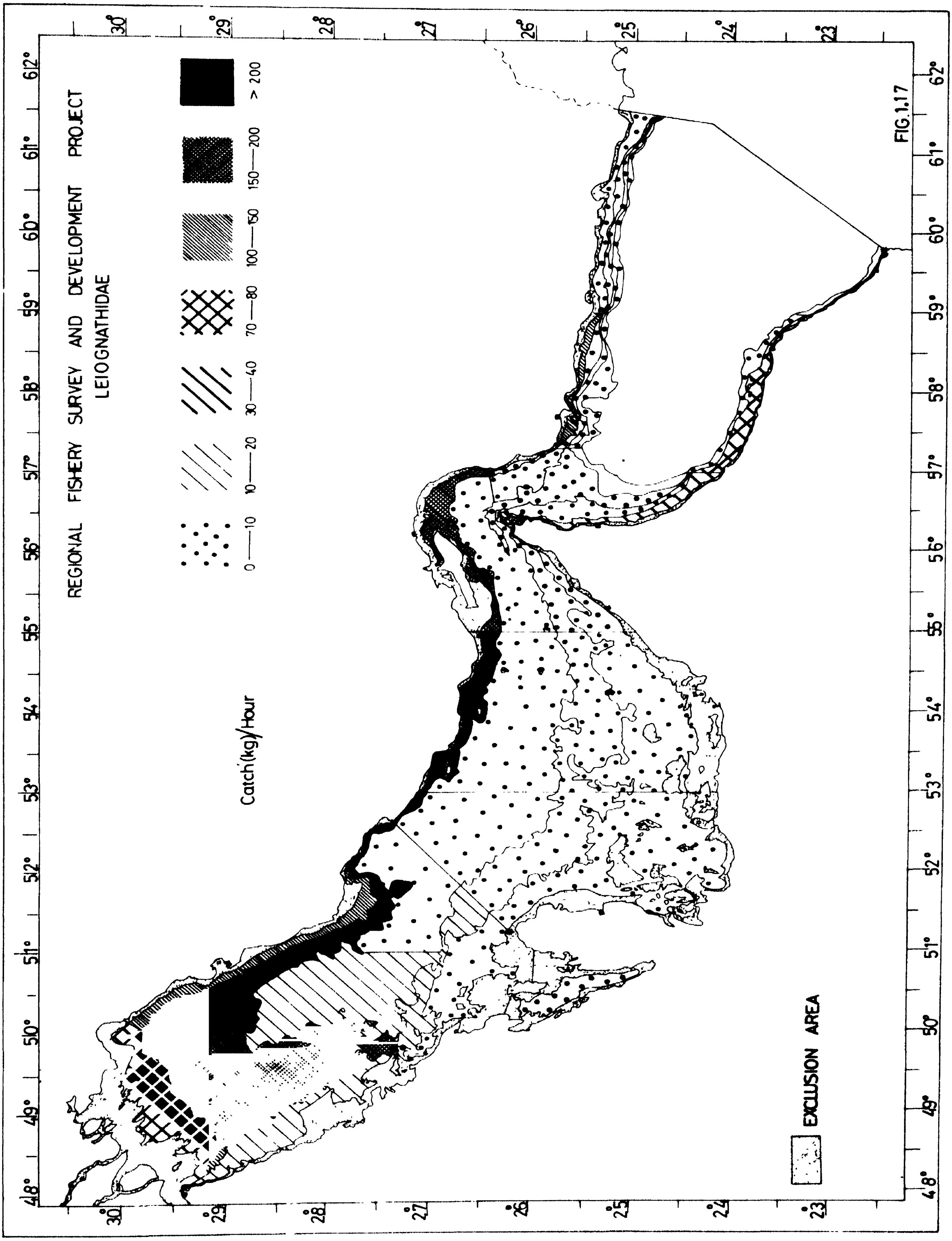

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
LEIOGNATHIDAE
0—10
10—20
30—40
70—80
100—150
150—200
> 200
Catch (kg)/Hour
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG.1.17

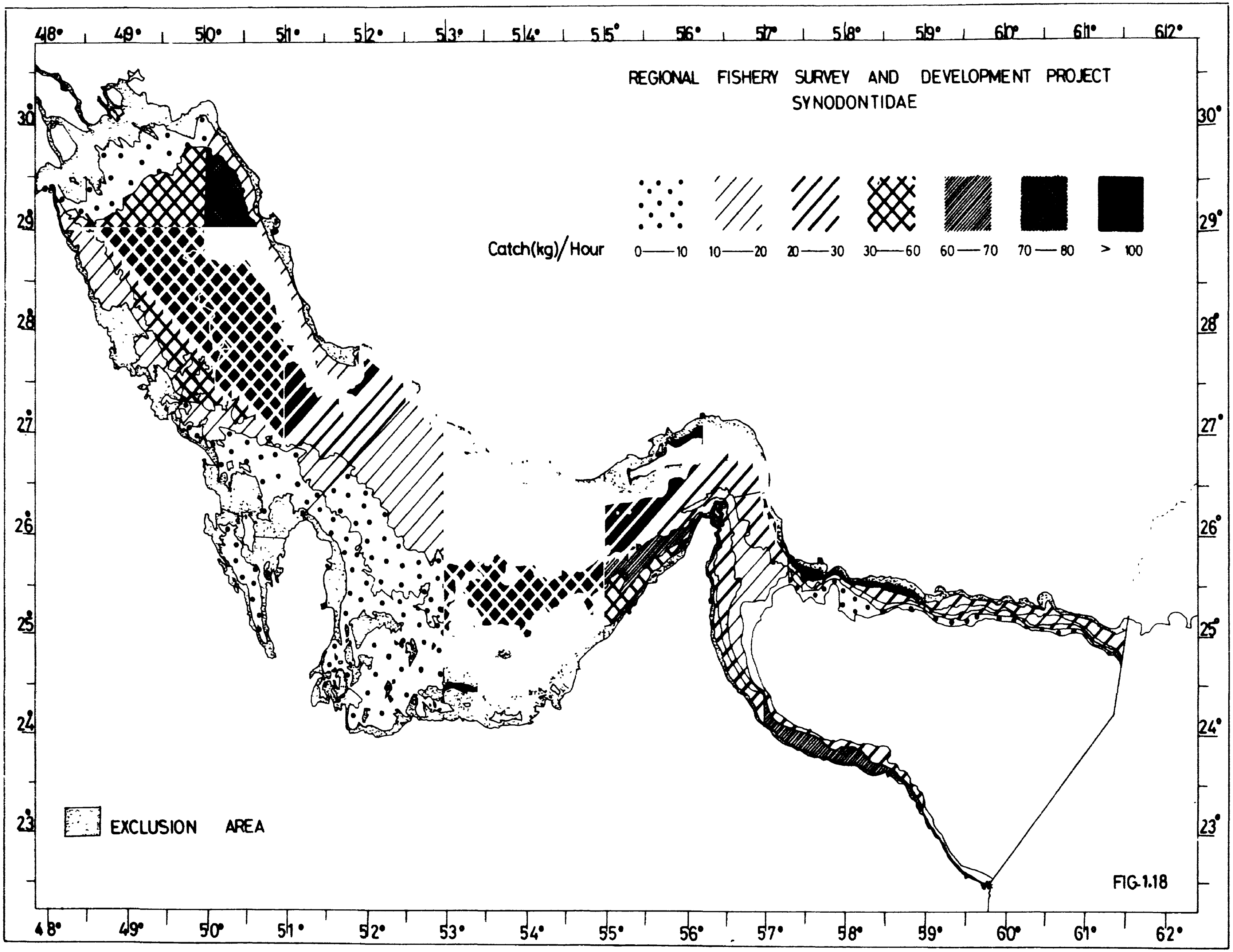

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
SYNODONTIDAE
Catch(kg)/Hour
0——10
10——20
20——30
30——60
60——70
70——80
> 100
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG.1.18

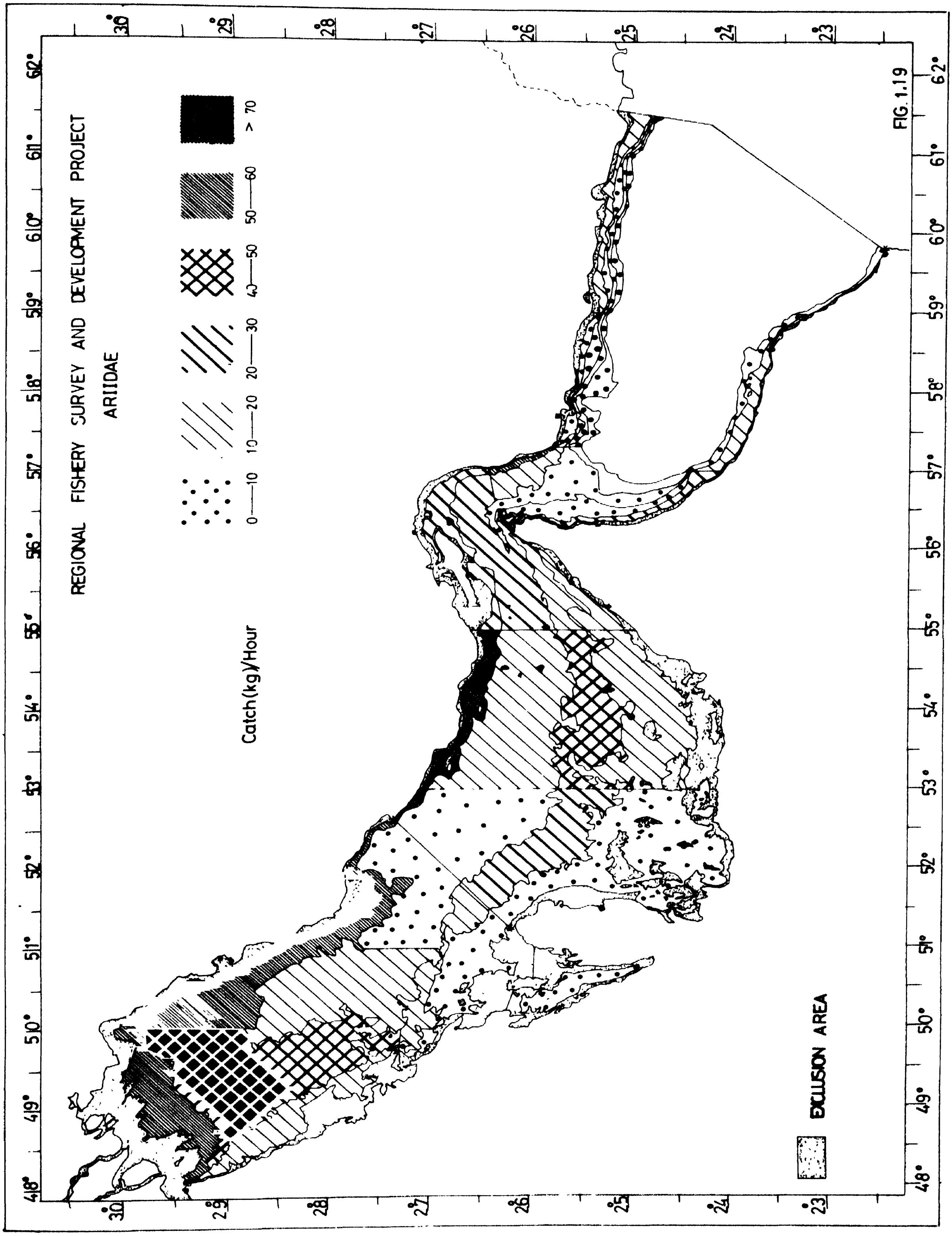

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
ARIIDAE
Catch (kg)/Hour
0—10
10—20
20—30
40—50
50—60
> 70
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23
24
25
26
27
28
29
30

FIG. 1.19

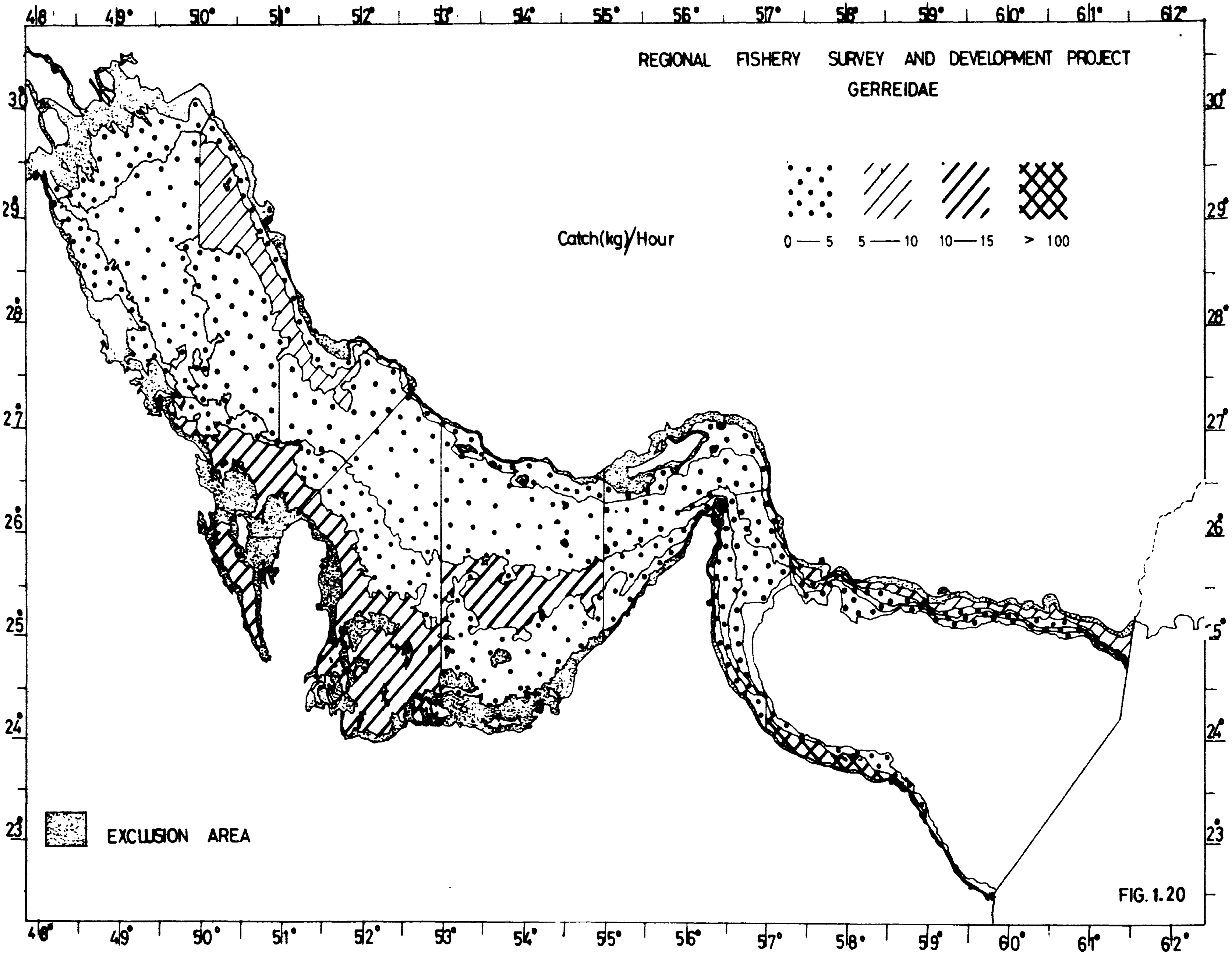
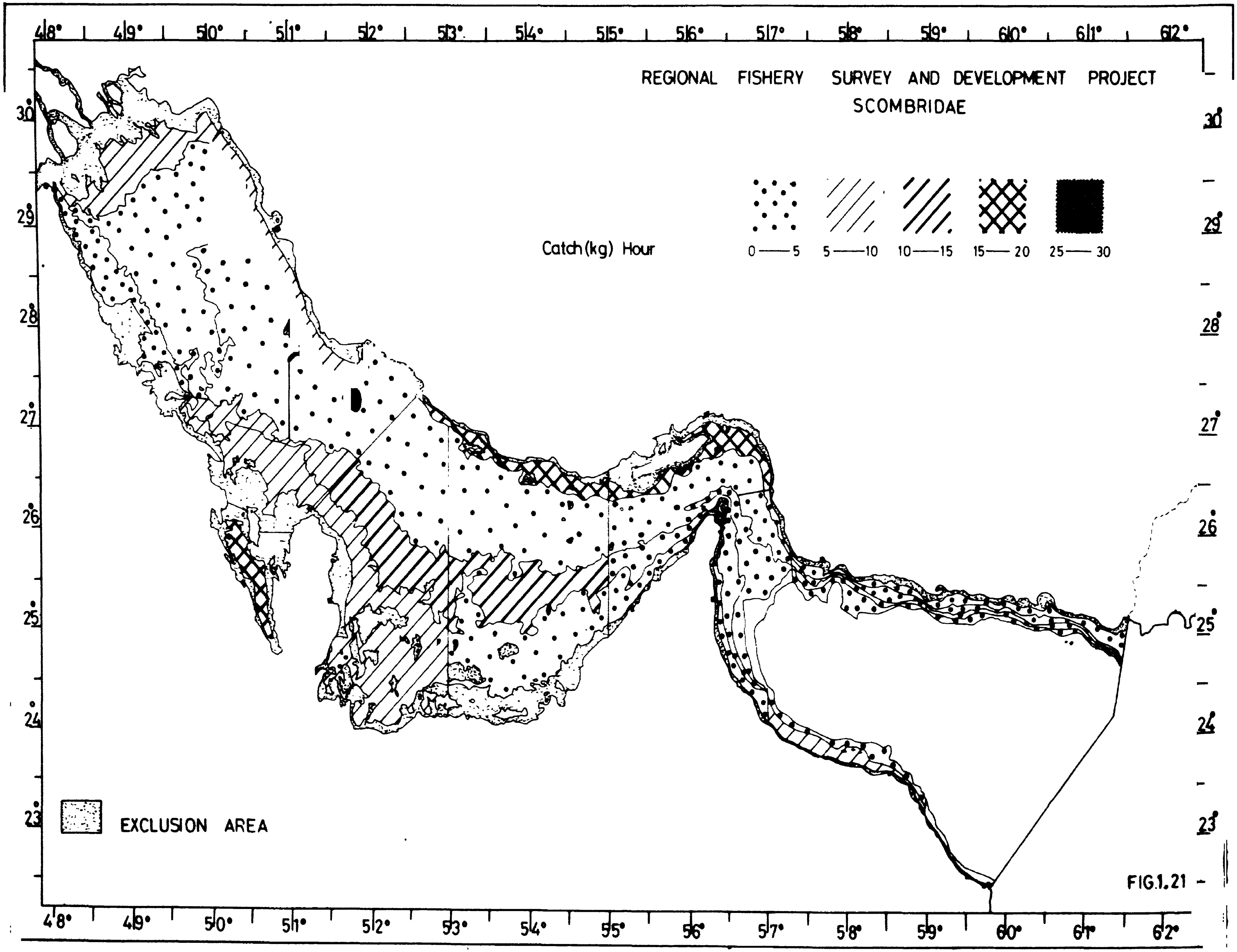

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
GERREIDAE
Catch(kg)/Hour
0 — 5
5 — 10
10 — 15
> 100
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG. 1.20



REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
SCOMBRIDAE

FIG.1.21

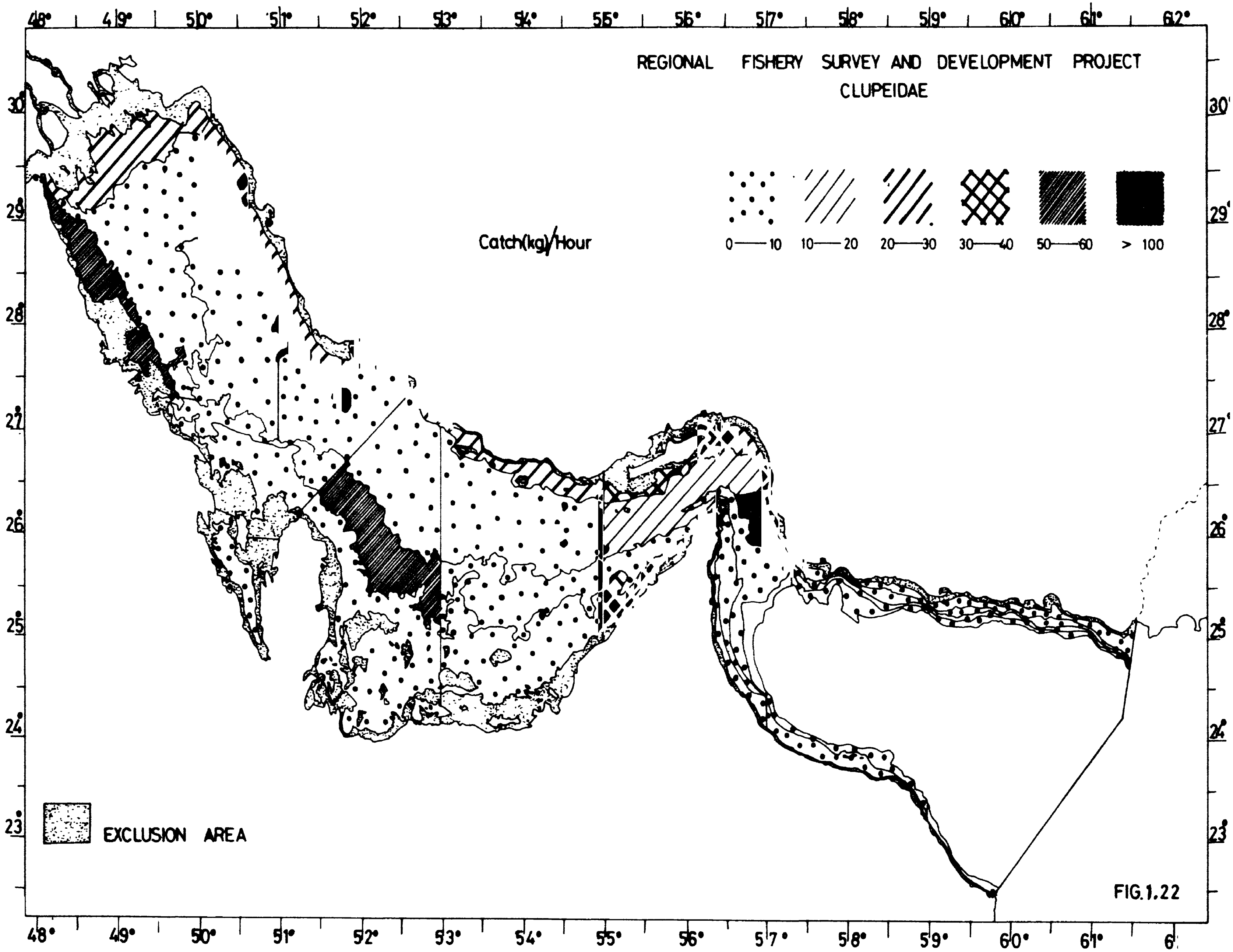

REGIONAL FISHERY SURVEY AND DEVELOPMENT PROJECT
CLUPEIDAE
Catch(kg)/Hour
0—10
10—20
20—30
30—40
50—60
> 100
EXCLUSION AREA
48°
49°
50°
51°
52°
53°
54°
55°
56°
57°
58°
59°
60°
61°
62°
23°
24°
25°
26°
27°
28°
29°
30°

FIG.1.22

Part 2

BIOLOGICAL INFORMATION COLLECTED DURING THE DEMERSAL RESOURCES SURVEY

Compiled by

K. Sivasubramaniam

2.1 INTRODUCTION

For various reasons, the biological information on a number of fish species caught during the demersal resource survey was insufficient for drawing firm conclusions, discussed in Part 1 of this report. However, the information collected is valuable and may serve as guidance for planning future investigations to be undertaken by the respective member countries at national or regional levels. It forms an input to data collection which should be systematically carried out by national fisheries laboratories and universities in the region for better understanding of the fish stocks.

The observations on the Arabian side and the relatively deep central part of the Gulf were made mainly between March and October of 1977 and 1978, which the Iranian side was investigated between October 1977 and April 1978. In the Gulf of Oman, the eastern half of the Oman coast was studied in March 1977, the eastern half of the Iran coast in May 1978, whereas the western half and area close to the Strait of Hormuz were investigated mainly in August 1977 and 1978. The basic sampling technique used is mentioned in the report FAO (1976) and Part 1 of this report.

2.2 SAMPLING PROCEDURE

It was generally observed that smaller specimens of the bigger types of species were poorly represented in the sampling, with the clear exception of forms like Argyrops spinifer and Sphyraena spp. This was so obvious that it was conjectured that they were probably concentrating on those grounds in the project area that were inaccessible to vessels or gear and therefore remained unsurveyed. Almost all of the large sized specimens caught were measured,being fewer in number. In cases of small fish,one or two boxes, depending on the catch size, were taken as samples. Most of these data were entered either on the biological sampling sheets if individual weights were measured, or on the length frequency sampling sheets when only lengths were measured.

For length frequency sampling, generally the entire sample was used in the case of medium sized fish, but for smaller species like Upeneus sulphureus, Saurida spp., Decapterus sp., Selar sp. or Trachurus sp., the samples were divided into smaller portions to diminish the size of sample to a level that could be practically handled. Sex, maturity of gonads and stomach contents were also examined onboard, depending on the time available between the trawl station.

2.3 BIOLOGICAL INFORMATION BY FAMILIES AND SPECIES

The observations made are presented below as summary notes on various species, grouped by families. English names are given as far as available on FAO Identification Sheets.

2.3.1 Ariommidae (driftfishes) · Ariomma indica (driftfish)

The main catches of Ariomma indica were made in the deeper waters of survey Areas 1 and 2, particularly the substratum 1B2 and all the 'C' strata. Very little of this species was found around the Strait of Hormuz and practically none in the Gulf of Oman.

A. indica was observed to be mature and in spawning condition during the period of study (March to July). In March they were already mature and in July there were still some maturing specimens and hence the spawning period could be extending to a few months longer than the period of observation. Males appeared to be fully mature at 14 cm and females at 16 cm. There were almost no males larger than 18 cm and all the larger specimens were females. The sex ratio observed was M/F = 1/0.92.

The general size-range has been 4-22 cm, but the samples show a remarkable domination by the group from 15-18 cm nearly everywhere and at all times. This is also practically the maximum size and it should be kept in mind that this species is almost unexploited at present by existing fisheries. A second group with a modal length around 12-13 cm appeared in the samples during May (substrata 1B2, 1C2, 2C2 and 2C3) and continued to do so until July and August. Smaller specimens, from 4 cm and above, were found in 1B2, 1B3, 1C2 and 2C2/3 during March mainly and a few during April and May. (Tables 2.1, 2.2 and 2.4), (Fig.2.1). Stomach contents were identified as crustaceans.

2.3.2 Ariidae (catfishes) - Arius thalassinus (giant catfish)

This species occurred in the catches in almost all substrata, but was found to be most abundant on the Iranian side and, to some extent, in the 2B stratum on the Arabian side.

It was found to be mature during March (1C2) and June (1B2). Fingerlings were observed during July (Kuwait Bay).

A. thalassinus caught were of the size range 10-87 cm, but large specimens were not abundant and the main size-range was generally between 30 and 40 cm. This modal length was observed during January, March and August in substratum 1C2, and from June to August in substratum 1B2. Smaller specimens from 10 to 20 cm were observed in December (1B1), March (2C2) and July (2B3). Modal length was a little larger (35-45 cm) during December (1B2) and July (2B3). (Tables 2.1, 2.2, 2.3 and 2.4). Stomach contents showed crabs, shrimps and squilla.

2.3.3 Carangidae (horse mackerels, scads, jacks, etc.)

(a) Decapterus spp. (scads)

Two species of Decapterus were observed: D. kiliche and D. russelli. In Areas 1 and 2 Decapterus was found in nearly all substrata, and among the scads and horse mackerels (Decapterus, Selar and Trachurus) it was found to be the dominant and most abundant species on the Iranian side in the 'B' stratum. In the Gulf of Oman Trachurus was not observed and Decapterus was also the dominant genus there.

D. russelli was observed a few times in substratum 1B2 in June, during which time it was found to be maturing and spawning at the size-range 14-19 cm, which was practically the whole size-range observed. Sex ration was 1/0.45 for 58 specimens.

D. kiliche appeared to be absent from a large part of Area 1 during March, whereas it was found there during May and later on, indicating that the species might be moving into that area during April. It was found maturing and spawning in April in substratum 2B2 and during July in substratum 1B2 with size-range of 15 and 25 cm. The sex ratio showed predominance of males (M/F = 1/0.16).

Size frequency samples were collected mainly from Area 1. During May only one mode was observed (at 14 cm) and from June to November this had increased to around 18 cm. A lesser mode was observed to be around 9 cm during June and this moved to 14 cm in November. (Tables 2.1, 2.2 and Fig. 2.3). Stomach contents revealed Thryssa and anchovy.

(b) Selar crumenophthalmus (bigeye scad)

Selar has appeared to be the least abundant of the horse mackerels, but it was the dominant species on the Arabian side of Area 2. Only a few good catches of Selar were made in substratum 3C2 on the Iranian side of the Gulf of Oman. Mature Selar was observed in substratum 1C2 during June. The size-range was 11-27 cm in Area 2 mainly, and 19-28 cm in the Gulf of Oman. Small specimens were hardly observed.

In Area 1 Selar was absent in the catches during March and May and appeared only during June, which suggests that they may be moving northward from Area 2, where the species appeared regularly during March to May (Tables 2.1, 2.2 and 2.4).

(c) Trachurus indicus

This species was most common amongst horse mackerels in Areas 1 and 2, where on an average it comprised 64% of the catches of this group, but it was hardly observed in the Gulf of Oman. T. indicus has been particularly dominant in most of the central part of the Gulf (substrata 1B2, 1B3) and all the 'C' strata, where it made up for 72-94% of the horse mackerels.

Mature and spawning specimens were observed during March (1C2), spawning and spent during May (1B2) with a size-range of 14-22 cm. The sex ratio M/F was 1/0.93 during March and 1/1.30 during May, or 1/1.04 for the combined observations.

The size-range for T. indicus was observed to be 5-22 cm mainly in Area 1. (Tables 2.1, 2.2 and 2.4; Figs. 2.3 and 2.4). Stomach contents included anchovies.

(d) Selaroides leptolepis (yellowstripe trevally)

This is a small Carangid, which appears to have its main distribution in the shallow waters between Bahrain and UAE in substrata 1A4, 2A1, 2A2 and 2A3, and during part of the year also in substrata 2B3 and 2B4, where the biggest catches have been made during October and November.

In the Gulf of Oman it was observed on the Iranian side only.

S. leptolepis observed were of the size-range 4-16 cm. The sampling for this species was most consistent in substrata 1A4, 2B3 and 2B4. Modal length was between 8 and 10 cm in general. Specimens under 7 cm appeared very seldom in the catches (Table 2.1).

(e) Seriolina nigrofasciata (black-banded trevally)

A common but not very abundant species in the trawl catches. Usually only a few specimens can be found in each haul. About 440 kg were caught during the survey, nearly all of it from Areas 1 and 2, and most of that was from the 'B' stratum.

The species was found to be mature and spawning during March (1C2), April (1B2), June (1A3) and July (1B2). They were already mature during March and some were still maturing in July, which again suggests a longer spawning period. Most of the larger specimens were females, and appear to be spawning at a size of 38 cm, whereas males were found to be mature from 33 cm onwards. The sex ratio M/F was observed to be 1/0.77.

The size-range of species was 13-50 cm, but mainly between 20 and 45 cm. The larger specimens have been observed in the 'C' stratum but found elsewhere later in the year (September and November). Small specimens have been observed only during November in substratum 2A2. (Tables 2.1, 2.2 and 2.4; Fig 2.5).

2.3.4 Chirocentridae (wolf herring) - Chirocentrus nudus (whitefin, wolf herring)

Another common but not very abundant species in the trawl catches. About 1 230 kg were caught during the survey, mainly in strata 1A, 1B, 2B and 2C. Very little were found in the Gulf of Oman.

Ch. nudus observed were of the size-range 36-93 cm, but mainly 40-80 cm. The combined data on size for Areas 1 and 2 would seem to indicate modal lengths around 45-50 and 65-70 cm. However it appeared that the main group of smaller specimens were mostly males, whereas those over 65 cm length were mostly females. This is an important consideration for further studies on this species. The sex ratio M/F was 1/0.89 (Tables 2.1, 2.2 and 2.4). Anchovies, Leiognathus and Trichiurus sp. were found in the stomach contents of this fish.

2.3.5 Lethrinidae (emperors, scavengers)

Four Lethrinus spp. have been found in the survey area, totalling about 14.5 t during the survey, of which 94% were caught in the 'A' and 'B' stratum between Bahrain and the UAE, and also in the 'B' stratum on the Oman side of the Gulf of Oman. Elsewhere they were found on banks around islands, etc., and most of these were Lethrinus nebulosus.

(a) Lethrinus haematopterus had not been properly identified at the beginning of the survey and was also called L. laticaudus. It has appeared to be the most abundant Lethrinus species during the survey, especially in the Gulf of Oman in the 2A stratum.

The size-range of this was from 9-26 cm and most samples showed two modal lengths. Unfortunately, due to the coverage of the areas, samples were widely dispersed between June and August 1977 and in November 1978 mainly. Some combinations of samples are shown in Fig. 2.6. In 1A4 and 1B3, from June to August 1977, the range was 9-23 cm with modes at 14 and 19 cm. In 2B3, during July of the same period, the range was 11-22 cm with modal lengths at 16 and 21 cm. During November 1978 intensive sampling was done in the 2A stratum and the general range was 10-27 cm, but for nearly the same range the modes were at 11 and 17 cm in 2A2, while they were at 19 and 25 cm in 2A1 (Table 2.1; Fig. 2.6).

(b) Lethrinus lentjan (redspot emperor) was most abundant in substrata 1A4, 1B3, 2B3 and 2B4. Only in one sample were spawners of the size-range 21-27 cm observed in July (substratum 1B2). The size-range of this species was 11-39 cm but between June-August 1977 samples were made in substrata 1A4 and 1B3 and these samples showed a similarity in size distribution with a size-range of 11-28 cm. Intensive sampling in substratum 2A2 during November 1978 revealed a size-range of 13-39 cm and the samples showed several modes (Tables 2.1, 2.2 and 2.4; Figs. 2.6b and 2.7).

(c) Lethrinus miniatus (longface emperor) appeared to be the least abundant of the Lethrinus sp. and was mainly found in substrata 2A1 and 2B4 during November 1978. Size frequency samples from substrata 2A1 and 2A2 during November 1978 showed the reverse of the trend shown by L. haematopterus during that month. Larger specimens tended to be more abundant in the hard coraline bottoms of 2A2 (Tables 2.1 and 2.4; Fig. 2.6c).

(d) Lethrinus nebulosus appeared to be distributed in more or less the same area as the other Lethrinus spp.,but was found to be a little more spread out in the northern area and was also found in the 'C' stratum of Areas 1 and 2.

At many trawl stations, especially outside its main area of distribution, this species was found in small numbers. Many observations were made on sex and maturity, but few spawning specimens were found. L. nebulosis was found to be spawning during April (substratum 1B3) at sizes greater than 34 cm. In May (substrata 2B3/4) they were between 22-67 cm and maturing, and in November (substratum 1B3) the size-range was 48-64 cm with many spent fish.

In many instances small numbers of specimens were found in the catches. Initially the samples were groupers with an interval of 5 cm. Two size-ranges appeared to be dominant and these were 20-35 cm and 50-65 cm. The small number of observations on maturity indicated an extended spawning season and that the first spawning probably occurs at the size-range of 35 to 45 cm. (Tables 2.1, 2.2, 2.4 and 2.5; Figs. 2.8 and 2.9).

2.3.6 Lutjanidae (snappers)

(a) Lutjanus argentimaculatus (mangrove red snapper)

This species, which in size and colour greatly resembles the red snapper L. malabaricus (discussed hereafter), was found mainly in substrata 1B3, 2B3/4 and 2C2/3. It was found to be spawning during April (1B3), the males of the size-range 53-74 cm and the females 49-73 cm. The general size-range observed was 27-88 cm, but the main range was between 50-75 cm Tables 2.1, 2.2 and 2.4).

(b) Lutjanus malabaricus (malabar red snapper)

This red snapper, the main representative of its group in the survey area, had been initially identified as L. erythropterus and L. sanguineus. It was mainly observed in the substrata 1B2/3, the 'B' and 'C' strata of Area 2 and on the Arabian side of the Gulf of Oman.

In the case of this species almost all of the specimens caught were measured and many of them were sampled for sex and maturity. However, only 18 specimens were found to be spawning during April (1B3, 2C2), May (1B2, 2B5) and June (1B2), and only 24 specimens were found in the post-spawned condition. The sex ratio was M/F = 1/1.52.

As in the case of Lethrinus nebulosis this might suggest that spawning may be taking place in the inaccessible areas and this tends to be supported by the size frequency distribution also.

L. malabaricus caught were of the size-range 7-79 cm but the size group 60-79 cm was predominant in all substrata and at nearly all times. These size ranges made up for 57% of the number sampled and were close to 90% of its catch in weight. In this case also numbers were small in the trawl stations and these data had to be combined into groups of substrata for periods of several months, and at first this was done with an interval of 5 cm between size groups. Grouping with a 5 cm interval, irrespective of season, showed very clearly predominance of larger specimens. (Fig. 2.10). Though the absence of relatively smaller specimens is not the usual pattern, it is not considered to be due to sampling errors. All specimens over 30 cm would have been sorted out of the catch if they were available and, furthermore, with their conspicuous deep-red colour, they are not easily missed in the catch on deck. Probably they were in the hard-bottom areas, coral reefs and/or the shallow waters of the exclusion areas. Whenever small specimens of this species appeared in the catches most often it was in relatively large numbers.

A few combinations of larger samples plotted with 2 cm intervals (Fig. 2.11) showed more modes, such as in substratum 1B2, for May and June. (Tables 2.1,2.2, 2.4 and 2.5; Figs. 2.10, 2.11 and 2.12). Stomach contents revealed crabs, Cephalopods, sardines, Upeneus sp., Decapterus, Trachurus, Leiognathus, shrimps and fish larvae.

2.3.7 Mullidae (goatfishes) - Upeneus sulphureus (yellow goatfish)

This small species has been the main representative of this family group in the survey area. At the beginning of the survey it had also been named Mulloidichthys but later it was concluded that it was Upeneus sulphureus. This species appeared almost everywhere, but most abundantly in Area 1 and on the Iranian coast. It was least abundant in the shallow water around Bahrain and Qatar (substrata 1A4, 1A5 and 2A1). In the Gulf of Oman it was mainly found in the 'B' stratum, on both sides.

Sampling was mainly in Area 1. In spite of regular observations, mature fish were not observed in March (1B2, 1C2) but during May (1B2) all sizes from 8.5-16.5 cm were found to be in a spawning condition.

U. sulphureus specimens observed showed a size-range of 7-16 cm and in the samples used for sex determination it was found that specimens over 14 cm were generally females.

During March 1978 many length frequency samplings were made in the southern part of substratum 1C2. These samples had different size-ranges, and the modal length of the samples varied between 11.0 and 13.0 cm. This variation, within one substratum and at the same time, appeared to be larger than even the differences observed between mean modal lengths for different substrata and irrespective of seasons. A few samples made in the Gulf of Oman indicate that the species grows bigger there, up to a size of 20 cm (Tables 2.1 and 2.2; Fig. 2.13). Amphipods and Polychaetae were observed in the stomach contents of this species.

2.3.8 Nemipteridae (threadfin breams)- Nemipterus japonicus (Japanese threadfin bream)

N. japonicus was found almost everywhere in the survey area, except for the 'A' stratum between Bahrain and UAE. It appeared to be most abundant on the Iranian side, especially in the Gulf of Oman and in the deeper water near the Strait of Hormuz. Inside the Gulf, this species was commonly observed in substrata with muddy bottom.

Mature and spawning samples were observed in March, April and June in substrata 1B2 and 1C2. They seem to mature when they are 13-14 cm. The membrane around the gonads of this species was not transparent but metallic-orange coloured and this has to be cut in order to determine sex and maturity properly. In the samples examined, nearly all specimens larger than 23 cm were males and the sex ratio was M/F = 1/1.30.

Length frequency sampling was mainly in Areas 1 and 3. In Area 1 the size-range was 5-29 cm. During March 1978 many samples were taken in substratum 1C2 which showed considerable difference in size-range and modes. Wherever a group of samples was available numbers were raised to the total catch. In March the mode was at 14 cm in substratum 1C2, but around 19 and 22 cm in substrata 1B2/3, which seems to suggest that the spawners may prefer the shallower water. Small specimens with a mode around 8-9 cm appeared in substratum 1B2 during May.

In Area 3, size-range was 10-31 cm on the Iranian side and 18-35 cm on the Arabian side. Samples taken on the Iranian side in the 'B', 'C' and 'D' strata showed smallest specimens to be in the 'D' stratum (100-200 m). (Tables 2.1, 2.2, 2.4 and 2.5; Figs. 2.14a and 2.14b). Stomach contents revealed Amphipods, shrimps, swimming crabs and Leiognathus sp.

2.3.9 Pomadasyidae (grunts, sweetlips)

In the survey area this family was represented by three main types: Plectorhynchus spp. (mainly P. pictus), Pomadasys spp. (mainly P. argenteus and P. maculatus) and Rhonciscus stridens. The last one made up nearly 65% of the catches of this group during the survey. The other Plectorhynchus spp. were P. fangi, P. gaterinus and P. schotaf. These certainly were not abundant, but since most of them have been caught on hard bottom they may have been underestimated in the survey results. Other Pomadasys spp., P. operculare and P. multimaculatum, occurred occasionally in the catches.

(a) Pomadasys argenteus was mainly found on the Iranian side and showed a size-range of 23-60 cm. A few specimens sampled in strata 2B and 2C showed maturing condition during March and May and spent fish in September. The species seems to be most abundant in Area 1. One big sample made around Kubr Island (substratum 1B2) showed two size groups, 20-35 cm and 50-60 cm.

(b) Pomadasys maculatus was abundant in Area 2 and it was the dominating Pomadasys species in Area 3; the size-range was 11-61 cm. In Areas 1 and 2 this size-range was 24-61 cm but in Area 3 a considerably smaller size-range of 11-31 cm was observed. During April, in substratum 2B1, samples showed two groups of 25-30 cm and 40-55 cm. (Tables 2.1, 2.2 and 2.4). Stomach contents were crabs, tunicates, Leiognathus and Gerreidae.

(c) Plectorhynchus pictus (painted sweetlip) was very common but not so abundant. It appeared mainly in the 2A stratum and the 'B' stratum of Areas 1 and 2, on the Arabian side. On the Iranian side it was rather rare.

In spite of regular sampling, only 6 females were observed to be in spawning and spent condition during June (substratum 1B1) and the size-range was 54-63 cm, whereas elsewhere specimens were always found to be with developing or resting gonads. The sex ratio M/F observed indicated a large proportion of females (1/2.59). The species was very well sampled for size frequency distribution but,due to the relatively low catches, resulted in poor sample sizes. (Tables 2.1, 2.2, 2.3, 2.4 and 2.5; Figs. 2.15 and 2.16). Polychaet, worms, shrimps, squilla, horse mackerel and lizardfish were identified in the stomach contents.

(d) Rhonciscus stridens is small and of little commercial value. It has been found in all the survey areas, but in Areas 1 and 2 it was seldom found in the 'C' stratum. It appeared to be abundant in the 'B', 'C'and 'D' strata in the Gulf of Oman, on both sides. In Areas 1 and 2 it was relatively most abundant in substrata 1A3, 1A4, 2A1 and 2B3/4, which appeared to be less coraline areas.

The species was observed to be in spawning condition during March, in substratum 1A3, where it was very abundant at that time. Size ranged from 9 to 19 cm but specimens larger than 15 cm were mainly found in the Gulf of Oman (Fig. 2.17).

The little information available may show a sampling bias, but suggests similarity in the pattern of distribution to those of Upeneus sulphureus and Selaroides leptolepis. Catch rates were again high during March in substratum 1A3 (108 kg/h) and only 15 kg/h during June. In substratum 1B2 the catch rates have never been high, but in substratum 1B3 they rose from almost zero in March to 81 kg/h during June (Tables 2.1, 2.2 and 2.4; Fig. 2.17).

2.3.10 Rachycentridae (cobias) - Rachycentron canadus (cobia)

R. canadus was found in almost all substrata, but in low numbers. It seems to be sparsely spread over the 'B' and 'C' strata of Areas 1 and 2 and a little less so in Area 3.

The species showed a size-range of 42-115 cm, but the majority were larger than 70 cm. Only 83 specimens sampled represented about 3/4 of the total caught during the survey. The biggest catch was made in substratum 1B3 on one of the banks during February 1979 and it consisted of 28 specimens ranging from 54-109 cm.

R. canadus is a valuable foodfish and the market statistics of Kuwait mention about 273 t landed during 1978, most of it in the second half of the year. (Tables 2.1 and 2.5).

2.3.11 Serranidae (groupers)

Epinephelus spp. made up for nearly all the catches of the family Serranidae in the survey area, with a little of Cephalopholis and some Anthias sp. (a small ornamental fish).

Among the Epinephelus spp., E. tauvina (hamoor) has been the dominant species (60%). It was found over all the survey area, but appeared to have a preference for the 'A' and 'B' strata on the Arabian side of Areas 1 and 2. In the Gulf of Oman it was found in the deeper water of the 'C' and 'D' strata.

The remainder of the Epinephelus spp. (40%), however, appeared to have more preference for the deeper water and are mainly found in the 'B' and 'C' strata of Areas 2 and 3, and deeper waters in the Gulf of Oman. Among those species two were dominant: E. chlorostigma and Epinephelus sp. (a greyish, large species, which was later considered to be E. epistictus).

(a) Epinephelus sp. (E. epistictus ?)

Fifty specimens were sampled in substrata 1C1/2 and 2C3 from March to May. Their size-range was 56-98 cm. (Tables 2.1 and 2.2; Fig. 2.18).

(b) Epinephelus tauvina (greasy grouper)

In spite of numerous observations E. tauvina were seldom found in maturing and spawning conditions. A few females between 40 and 80 cm were found in spawning state in substrata 2B3/4 between March and May. During April, in substrata 2C2/3, three females were found to be spawning (51, 53 and 83 cm) and two males also showed very ripe gonads (56 and 61 cm).

There appeared to be a large proportion of females in the samples and the sex ratio M/F was 1/7.5. Most males seemed to be larger than 80 cm. Transsexual specimens were observed at the size-range 75-92 cm. The species is known to be protogynously hermaphroditic and the observations fit well with this knowledge. Often the gonads were found to be heavily parasitized.

E. tauvina showed a size-range 23-98 cm in the catches. The species had been very well sampled; nevertheless samples had to be combined for substantial areas and longer period of time, and had to be grouped under a 5 cm interval. Combined observations for strata 1A, 1B, 2A, 2B, 1C and 2C showed a difference in general position of the modes (Fig. 2.10). These were 60-65 cm in the 'A' strata, 55-60 cm and 70-75 cm in the 1B stratum, whereas in the 2B stratum the modal length was between 70-75 cm only. In the combined 'C' stratum only 35 specimens were found with a size-range of 51-95 cm. Small specimens were rather rare in the samples.

The bulk of the catch was made up of fish between 55-80 cm in length. The few small specimens observed were in the period between November (2A1/2) to March (1A2/3/4 and 1B2/3). (Tables 2.1, 2.2 and 2.4) (Figs. 2.19 and 2.20). Therapons, threadfin, bream, ponyfish, goatfish and cardinal fish were identified in the stomach contents of this fish species.

(c) Epinephelus chlorostigma

This species was sampled in substrata 2B3 and 2C3 during April/May. Size-range of the catches was between 19-75 cm and the combined samples showed modal groups around 30, 50-60 and 70-75 cm. (Table 2.3).

(d) Epinephelus aerolatus (areolated grouper) is a smaller species which was sporadic in the catches. Only 209 kg were caught during the survey, half of which was from Area 2.

The species sampled, mainly in Area 1, was of the size-range 10-50 cm. Combined data showed a modal length of 25-30 cm. In Area 2 the size-range was 23-38 cm. (Tables 2.1 and 2.2).

2.3.12 Sparidae (seabreams) - Argyrops spinifer (longspine seabream)

In the family Sparidae, Argyrops spinifer was by far the most important species and was found almost everywhere. In the 'A' strata it contributed 36%, in the 'B' and 'C' strata 81%, and in the 3D and 3E strata 100% of the catches of this family. Six other species groups, like Cheimerius nufar, Crenidens crenidens, Diplodus kotschyi, Mylio spp.,Pagellus, sp. and Rhabdosargus sp., which are either not abundant or mainly occur in shallower water or on hard bottom, were recorded.

A. spinifer was not observed in a state of spawning and only three females were observed in post-spawned condition during April (substratum 1B3, 2C3). Sex ratio M/F was 1/0.72. The size-range observed was 7-79 cm, but the main range was 10-30 cm. In fact large specimens may be over represented in the samples.

Length frequency sampling was done mainly in Areas 1 and 2, and 86% of that was carried out between the middle of March and middle of June. With an average of 1% Sparidae in the catches, the numbers of A. spinifer in the subsample for the catch composition has most often been restricted to around 10 specimens, and for this reason the species could not be very well sampled. (Tables 2.1, 2.2 and 2.4; Figs. 2.21 and 2.22). Stomach contents revealed crabs, shrimps, cephalopods and pieces of shells.

2.3.13 Synodontidae (lizardfishes)

About 99% of the catches of the family Synodontidae consisted of two species, S. tumbil and S. undosquamis. These species appear to be very similar at first sight and therefore had not been distinguished at the beginning of the survey. Both species appear mainly in the 'B' and 'C' strata of Areas 1 and 2, whereas in the Gulf of Oman only S. tumbil was observed in the 'B' and 'C' strata on both sides. In the 'A' stratum the major part of the catches were made during March (substratum 1A3) and April (substratum 2A2) but during the rest of the year they were either absent or scarce.

(a) Saurida tumbil (greater lizardfish) appeared to be most abundant on the Iranian side. It was observed in maturing and spawning conditions from March to July. The catches of this species showed a size-range of 13-47 cm and most specimens larger than 33 cm were found to be females. Sex ratio M/F was 1/0.93. (Tables 2.1, 2.2, 2.4 and 2.5; Fig. 2.24). Stomach contents showed ponyfish, goatfish, barracuda (young) and cardinal fish.

(b) Saurida undosquamis (brushtooth lizardfish) in mature and spawning conditions were seen during March only (in substrata 1B3 and 1C2). In substrata 1B3 the size was greater than 17 cm and in substratum 1C2 it was greater than 23 cm during the same cruise. Sex was easily distinguished in fish above 15 cm. The sex ration for the range 15-45 cm was M/F = 1/0.68, but for 15-24 cm M/F = 1/0.36, 25-35 cm M/F = 1/2.16 and those larger than 36 cm were almost entirely females.

S. undosquamis size-range in the catches was 4-45 cm. The samples were added after raising the numbers to the total catches. The results (Fig. 2.23) show that the main modes have been the same in both substrata (1B2/3 and 1C2) at 17 and 23 cm. Both smaller and larger specimens appeared to be a little more abundant in the deeper 'C' stratum. In August, it appeared that the larger specimens had disappeared from the substratum 1B2 and a few samples appeared in substratum 1C2, but no specimens larger than 34 cm were found. Eventual movements were not confirmed by the catch rates. (Tables 2.1, 2.2, 2.4 and 2.5; Figs. 2.23 and 2.24). In the case of this species the stomach contents revealed the presence of horse mackerel and squids.

Table 2.1

SUMMARY OF INFORMATION ON MAIN SPECIES SAMPLED FOR LENGTH FREQUENCY DISTRIBUTION

Species	Ns[1]	Ni	Observation Period	Size Range (cm)	Main Range (cm)
Ariomma indica	41		Mar-Aug	4-22	15-19
Arius thalassinus	17		Jan-Dec	10-87	20-45
Decapterus kiliche	19		May-Nov	8-26	10-20
Selar crumenophthalmus	9		Apr-July/Nov	13-30	
Trachurus indicus	37		Mar-Nov	5-22	9-20
Selaroides leptolepis	18		Mar-Oct	7-16	8-14
Seriolina nigrofasciata		474	Mar-Nov	13-50	20-45
Chirocentrus nudus		147	Jan-June	40-93	40-80
Lethrinus haematopterus	18		Apr-Nov	9-26	12-24
Lethrinus lentjan	21		Apr-Nov	11-39	12-27
Lethrinus miniatus	15		Apr-Nov	10-36	14-30
Lethrinus nebulosus		1 926	Jan-Nov	12-69	20-69
Lutjanus argentimaculatus		100	Apr-Sept	27-88	50-75
Lutjanus malabaricus		1 723	Jan-Nov	7-79	20-75
Upeneus sulphureus	45		Mar-Dec	7-20	10-15
Nemipterus japonicus	49		Mar-Dec	5-35	10-25
Pomadasys argenteus		122	Jan-May	23-60	23-60
Pomadasys maculatus		310	Dec-July	11-56	11-56
Plectorhynchus pictus		642	Jan-Nov	12-75	12-75
Rhonciscus stridens	9		Mar-Sept	8-19	8-19
Rachycentron canadus		83	Feb-Oct	42-115	70-100
Epinephelus sp. (epistictus ?)			Mar-Oct	56-98	56-98
Epinephelus tauvina		839	Jan-Nov	23-98	30-80
Epinephelus aerolatus		46	Mar-July	10-50	20-40
Argyrops spinifer		747	Mar-Oct	7-77	10-30
Saurida tumbil	9		Mar-July	7-49	7-49
Saurida undosquamis	30		Mar-Nov	4-45	4-45

[1] Ns = number of samples

Ni = number of individual specimens

Table 2.2

SUMMARY OF INFORMATION ON MAIN SPECIES SAMPLED FOR MATURITY

Species	Ni[1]	Observation Period[2]	Spawning Observed[2]	Sex Ratio M/F	Minimum size (cm) of spawners
Ariomma indica	251	Mar-July	Mar-July	1/0.9	16
Arius thalassinus	134	Mar/June	Mar/June	1/1.3	35
Decapterus kiliche	78	Apr/July	Apr/July	1/0.2	16.5
Selar crumenophthalmus	102	Apr/June	June	1/1.0	
Trachurus indicus	338	Mar-Nov	Mar-May	1/1.0	13-14
Seriolina nigrofasciata	101	Mar-July	Mar-July	1/0.8	38
Chirocentris nudus	125	Mar-June	April	1/0.9	40
Lethrinus lentjan	55	June-July	July	1/0.4	21
Lethrinus nebulosus	384	Jan-Nov	April	1/0.9	34
Lutjanus argentimaculatus	94	Apr-May	April	1/0.8	54
Lutjanus malabaricus	833	Jan-Nov	Apr-June	1/1.5	
Upeneus sulphureus	165	Mar-May	May	1/0.8	8
Nemipterus japonicus	324	Dec-June	Mar/June	1/1.3	14
Pomadasys maculatum	97	Dec-May	April	1/1.1	40
Plectorhynchus pictus	97	Mar-Nov	June	1/2.6	39
Rhonciscus stridens	80	March	Marcn	1/0.9	10
Epinephelus sp. (epistictus ?)	28	April-May	-	1/2.5	
Epinephelus tauvina	304	Mar-Oct	Mar-May	1/5.8	51
Epinephelus aerolatus	32	Apr-July	April	1/2.6	
Argyrops spinifer	165	Mar-June/Oct	Mar-April	1/0.7	
Saurida tumbil	143	Mar-July	Mar-July	1/0.9	23
Saurida undosquamis	380	Mar-July	March	1/0.7	17

1/ Ni = number of individual specimens

2/ Observation and spawning periods indicated by the hyphen (March-July) are continuous and those by the diagonal (April/July) indicate specific months

Table 2.3

SUMMARY OF INFORMATION ON SPECIES WHICH WERE OCCASIONALLY SAMPLED FOR SIZE AND MATURITY

Species	Size-range (cm)	Spawning Observed	Sex Ratio M/F	N[1/]
Alepes djeddaba	27-32	June	1/0.3	10
Alepes mate	18-30			
Alepes melanoptera	13-27			
Carangoides bajad	12-63	April	1/0.7	22
Carangoides chrysophrys	13-71			
Carangoides malabaricus	12-31		1/0.7	83
Decapterus russelli	8-19	April/June		
Seriola dumerili	77-84	April	1/1	6
Dussumieria acuta	13-17	April	1/0.4	25
Drepane punctata	17-45	April	1/0.8	36
Leiognathus bindus	4-11	June	1/0.6	149
Plectorhynchus schotaf	16-71			
Psettodes erumei	19-58	April	1/1	32
Otolithes ruber	18-48	Mar-June	1/1.3	95
Rastrelliger kanagurta	16-25	April-June	1/1.6	47
Epinephelus chlorostigma	19-75			
Siganus canaliculatus	8-25			
Cheimerius nufar	24-76			
Mylio bifasciata	16-33			
Sphyraena jello	32-74	April/July	1/0.8	38
Sphyraena obtusata	16-34	May		
Sphyraena genei	27-115			
Trichiurus haumela	36-117			

[1/] N = number of specimens used for maturity sampling

Table 2.4

LENGTH-WEIGHT RELATIONSHIP FOR SOME SPECIES

Ariomma indica	4-22 cm	$W = 0.02\ LT^{2.91}$	
Arius thalassinus	20-44 cm	$W = 0.01\ LT^{3.25}$	
Selar crumenophthalmus	13-30 cm	$W = 0.01\ LT^{2.97}$	
Trachurus indicus	10-18 cm	$W = 0.02\ LT^{2.84}$	DARBAT
Trachurus indicus	14-19 cm	$W = 0.03\ LT^{2.62}$	LAVAN 03
Seriolina nigrofasciata	22-46 cm	$W = 0.024\ LT^{2.807}$	
Chirocentris nudus	40-80 cm	$W = 0.0016\ LT^{3.20}$	
Lethrinus lentjan	12-27 cm	$W = 0.02\ LT^{2.91}$	
Lethrinus miniatus	19-36 cm	$W = 0.017\ LT^{2.87}$	
Lethrinus nebulosis	12-65 cm	$W = 0.02\ LT^{2.90}$	Area 1
Lethrinus nebulosis	36-67 cm	$W = 0.035\ LT^{2.73}$	Area 2
Lutjanus malabaricus	36-73 cm	$W = 0.052\ LT^{2.70}$	SABAH (1A/1B3)
Lutjanus malabaricus	18-75 cm	$W = 0.02\ LT^{2.99}$	LAVAN (1B2)
Lutjanus malabaricus	10-79 cm	$W = 0.026\ LT^{2.84}$	AL BAHETH (1B3, 1C)
Lutjanus malabaricus	55-75 cm	$W = 0.003\ LT^{3.36}$	DARBAT (2B, 2C)
Nemipterus japonicus	16-26 cm	$W = 0.03\ LT^{2.72}$	DARBAT (Area 3)
Nemipterus japonicus	14-30 cm	$W = 0.06\ LT^{2.53}$	DARBAT (Area 2)
Nemipterus japonicus	10-22 cm	$W = 0.038\ LT^{2.65}$	LAVAN 03 (Area 1)
Plectorhynchus pictus	17-74 cm	$W = 0.019\ LT^{2.875}$	AL BAHETH
Rachycentron canadus	68-95 cm	$W = 0.004\ LT^{3.12}$	
Epinephelus tauvina	58-91 cm	$W = 0.011\ LT^{3.056}$	SABAH (Area 1)
Epinephelus tauvina	43-95 cm	$W = 0.005\ LT^{3.266}$	AL BAHETH (Area 1)
Epinephelus tauvina	31-98 cm	$W = 0.008\ LT^{3.122}$	AL BAHETH (Area 2)
Epinephelus tauvina	47-87 cm	$W = 0.002\ LT^{3.457}$	DARBAT (Area 2)
Argyrops spinifer	12-72 cm	$W = 0.061\ LT^{2.609}$	AL BAHETH
Argyrops spinifer	17-22 cm	$W = 0.076\ LT^{2.56}$	LAVAN 03
Saurida tumbil	13-42 cm	$W = 0.008\ LT^{3.007}$	
Saurida undosquamis	14-35 cm	$W = 0.01\ LT^{2.99}$	

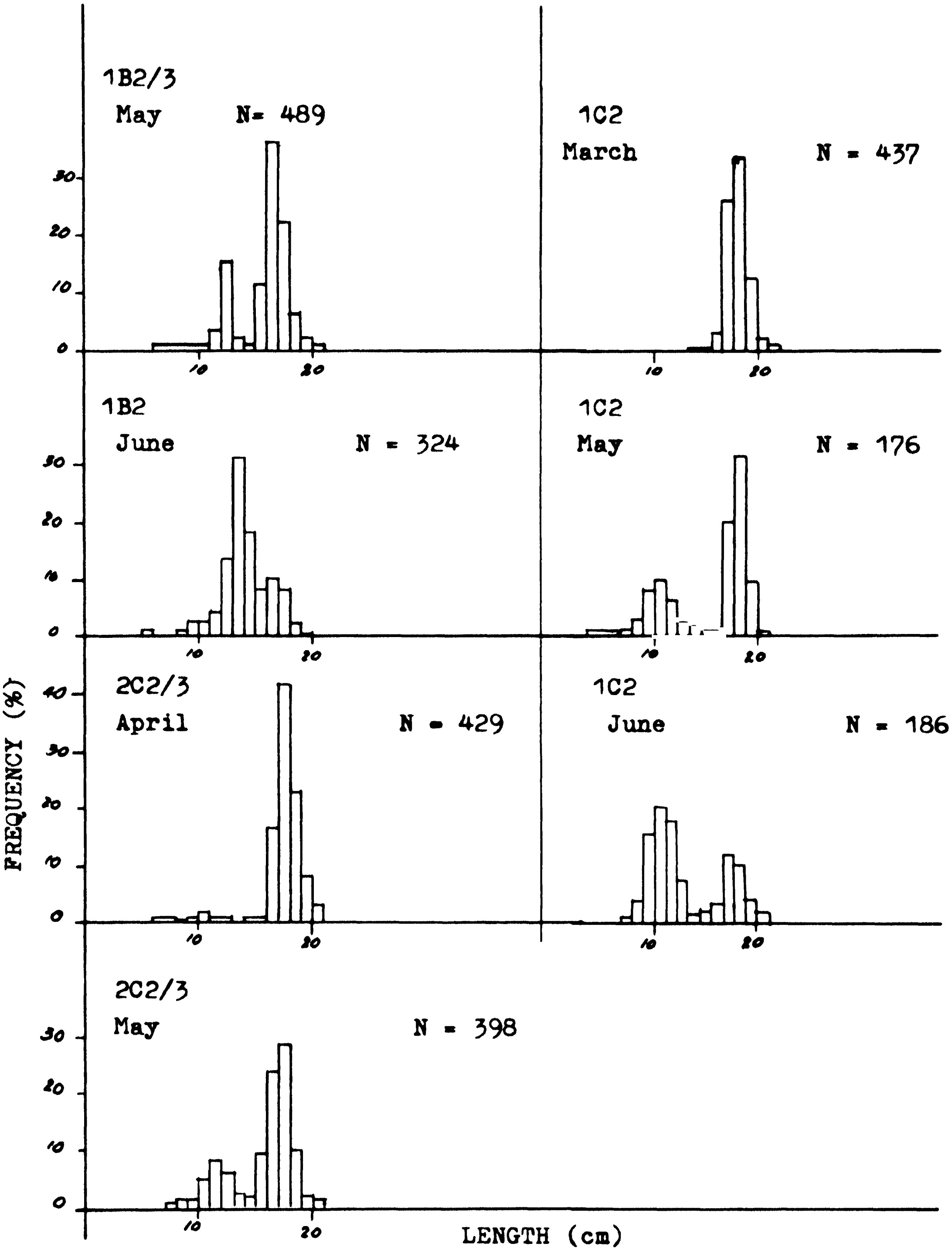


Fig. 2.1 Length frequency distribution of *Ariomma indica*

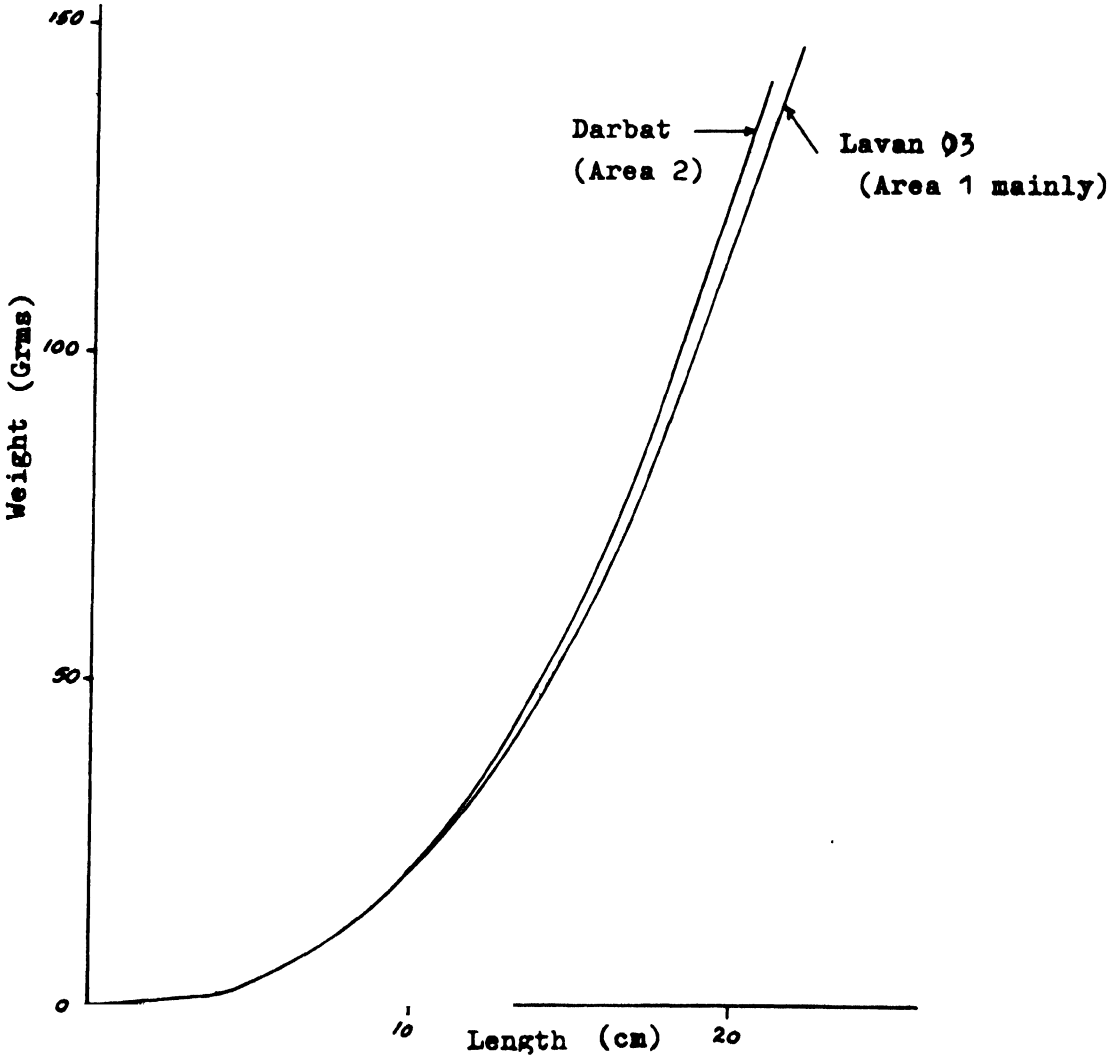


Fig. 2.2 Length-weight relationship for Ariomma indica

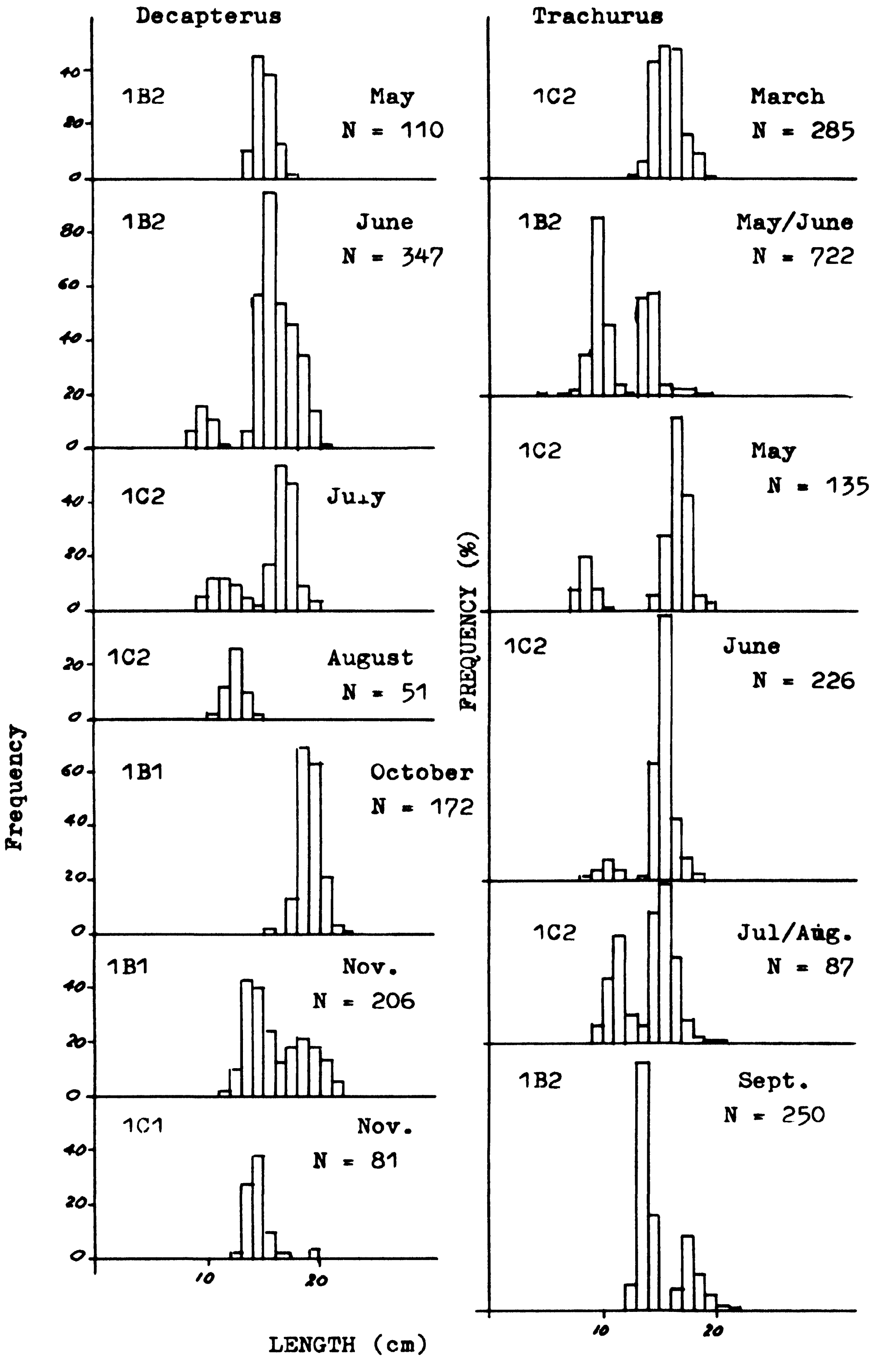


Fig. 2.3 Length frequency distribution of Decapterus sp. and Trachurus sp.

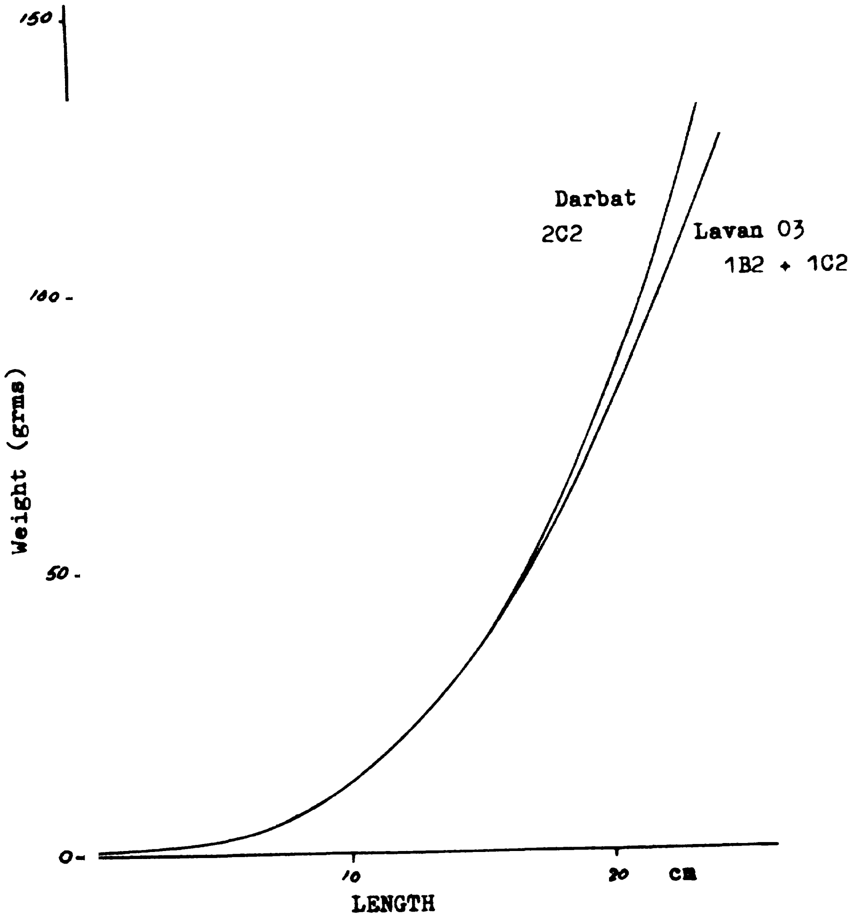


Fig. 2.4 Length-weight relationship for Trachurus indicus

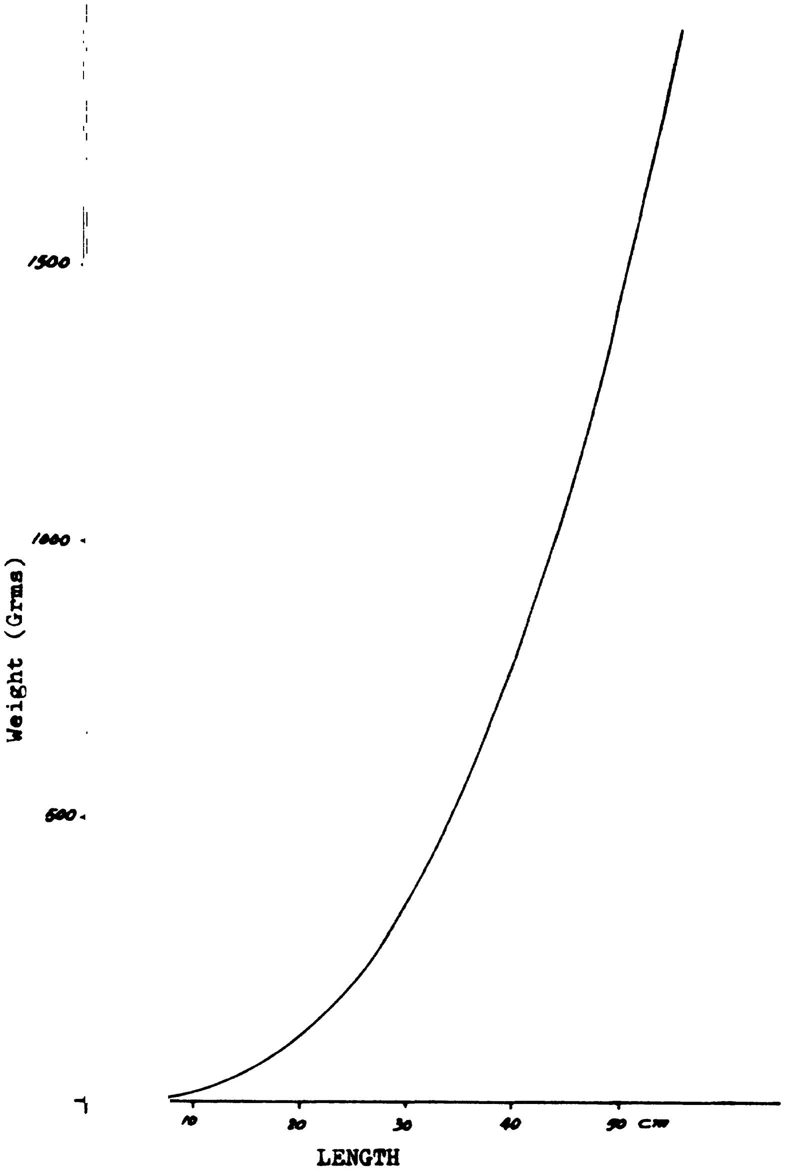


Fig. 2.5 Length-weight relationship for Seriolina nigrofasciata

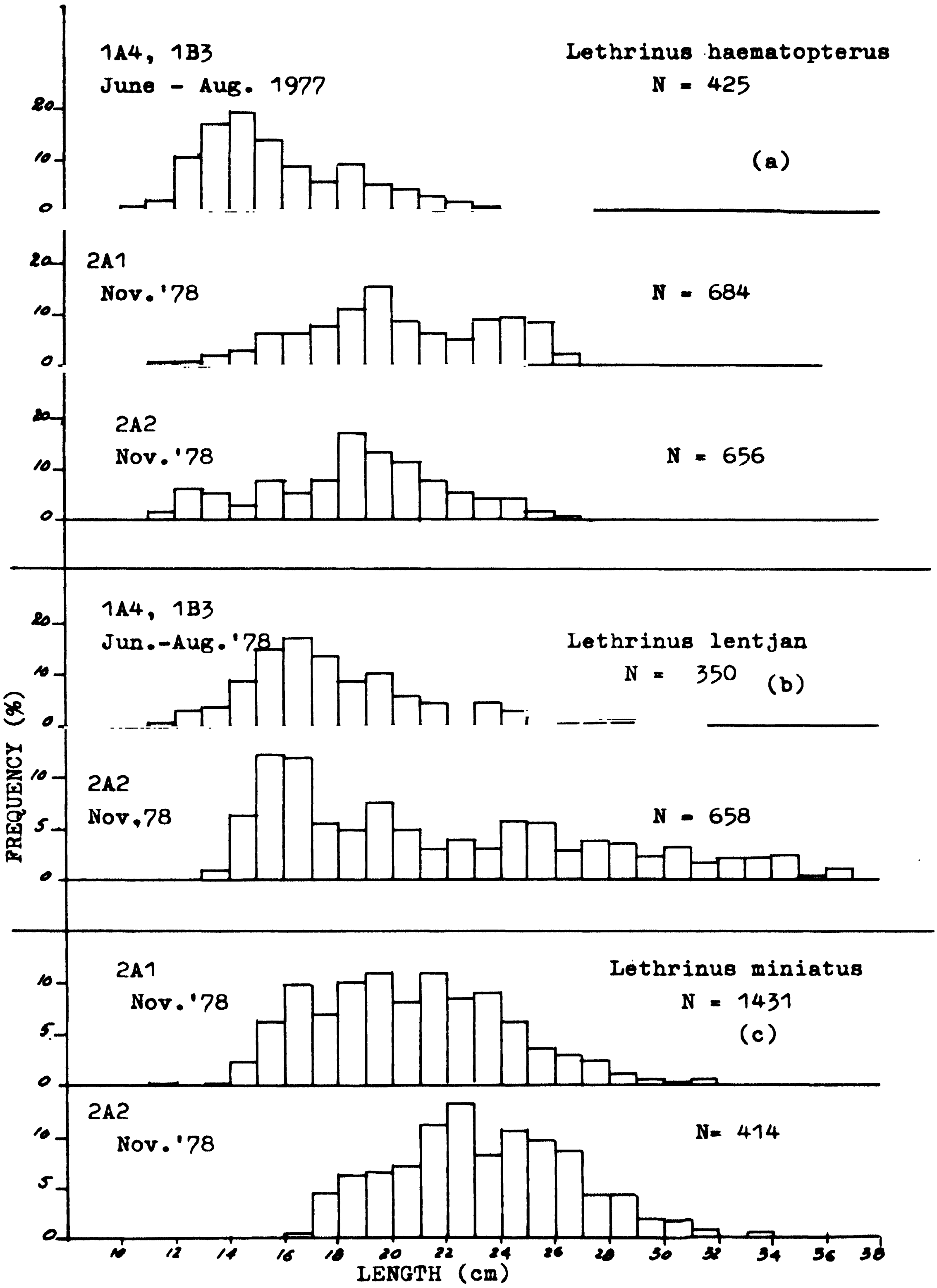


Fig. 2.6 Length frequency distribution for Lethrinus species

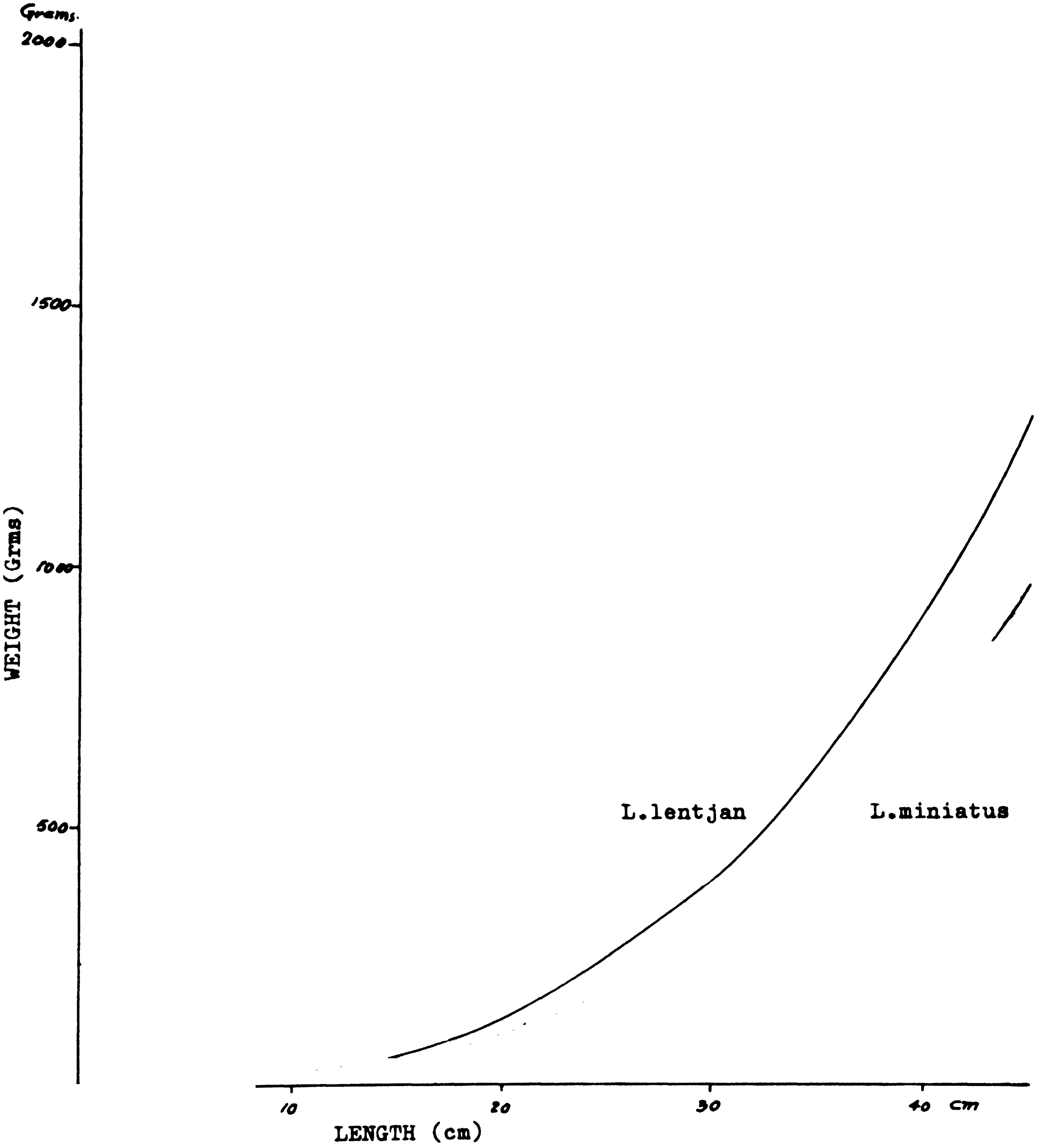


Fig. 2.7 Length-weight relationship for Lethrinus species

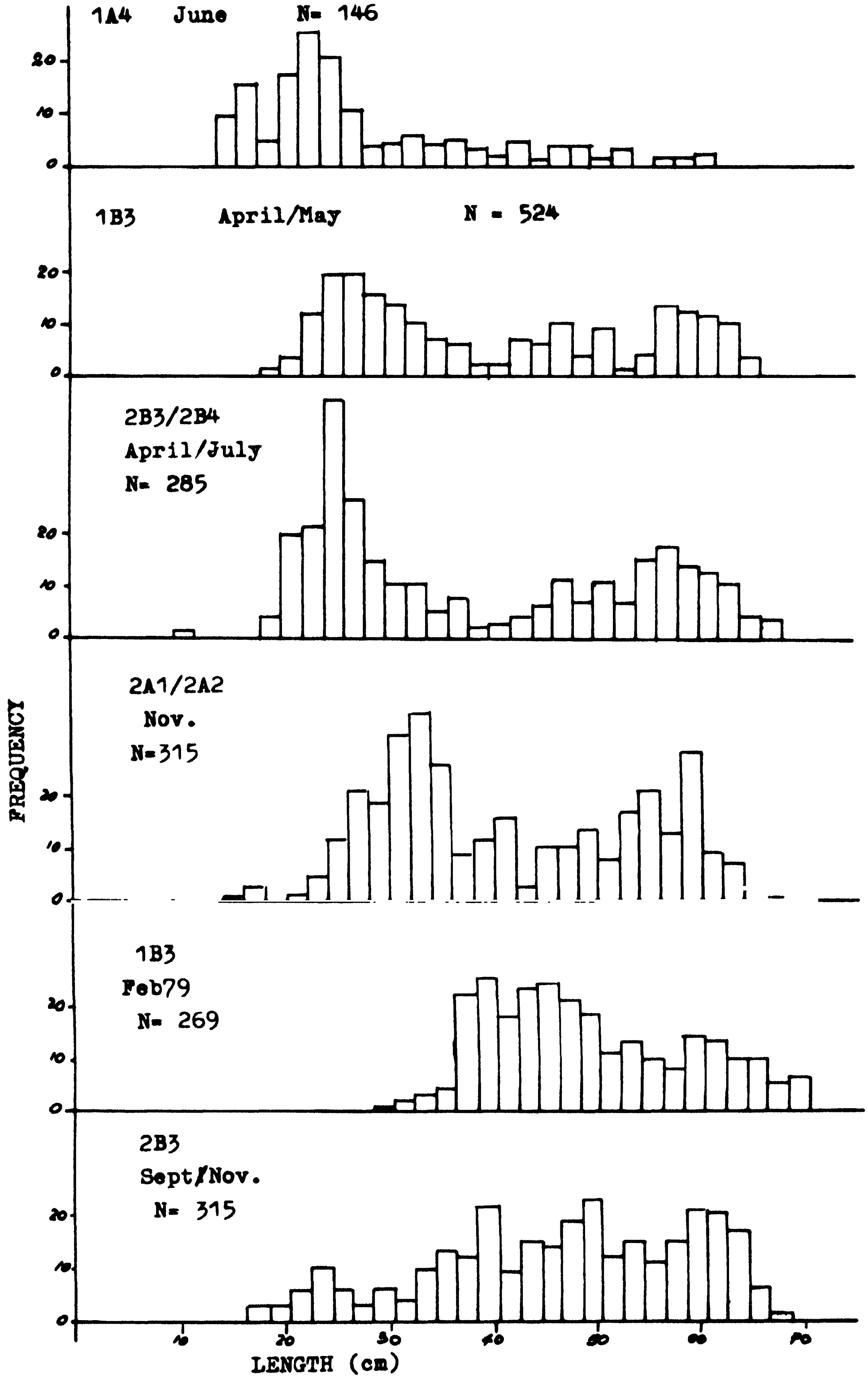


Fig. 2.8 Length frequency distribution of Lethrinus nebulosus

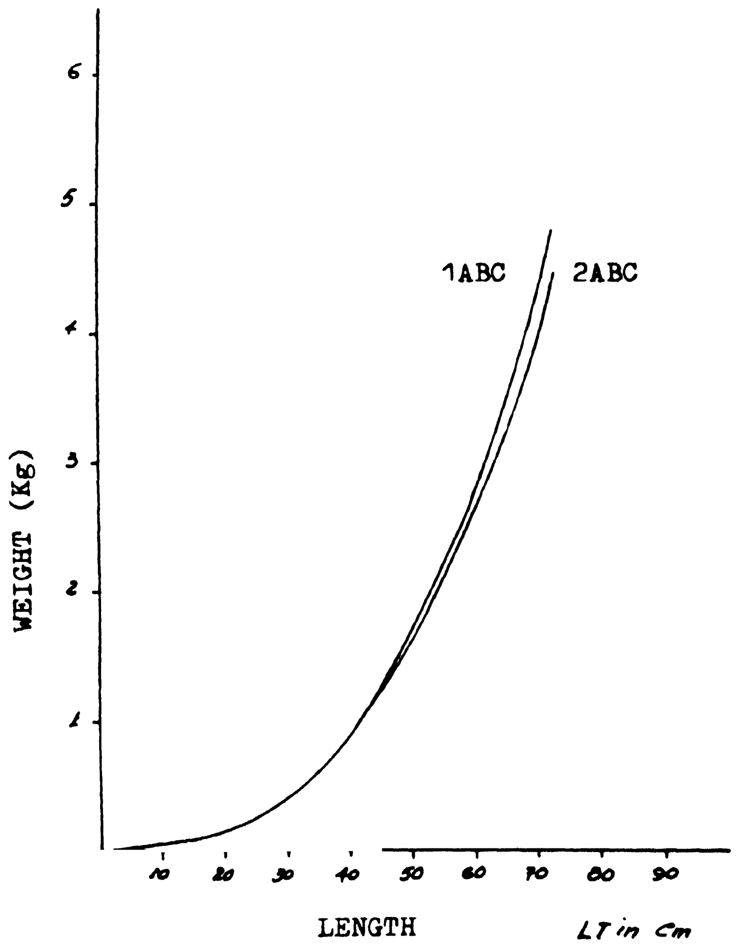


Fig. 2.9 Length-weight relationship for *Lethrinus nebulosus*

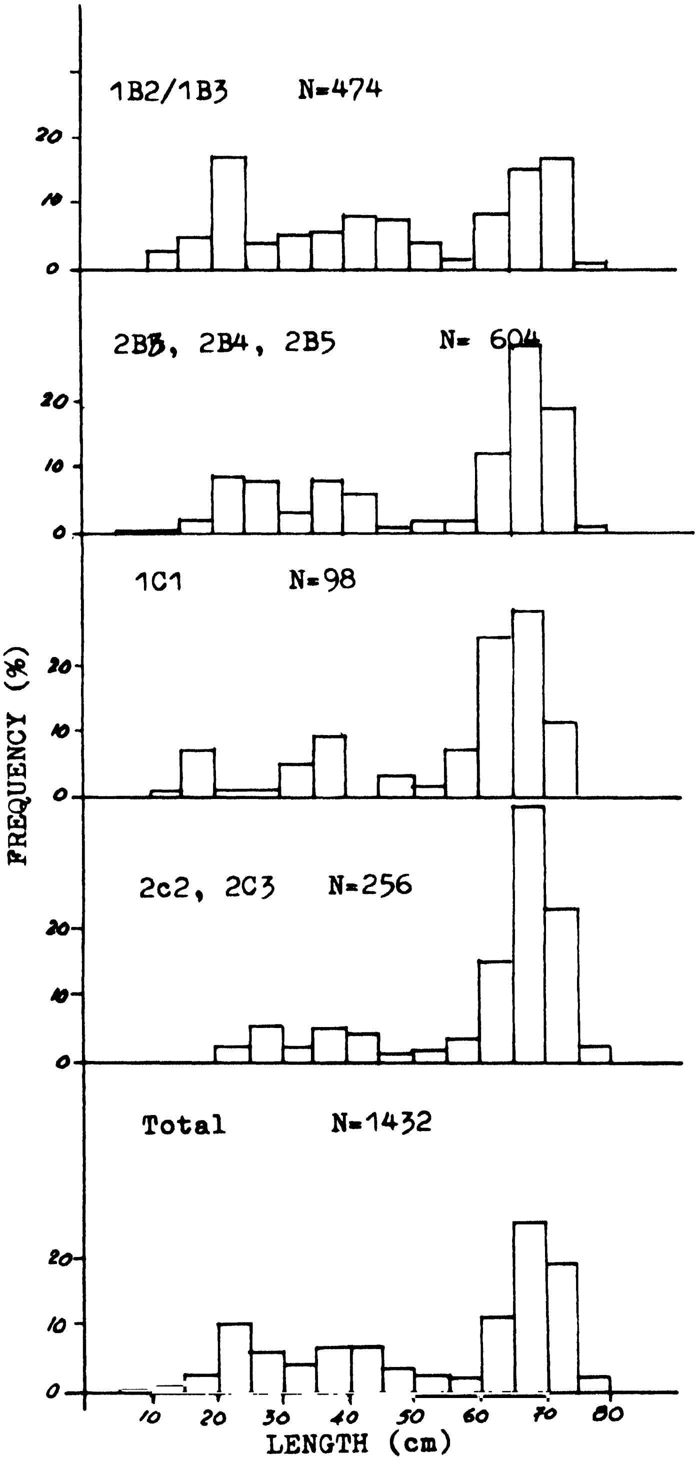


Fig. 2.10 Length frequency distribution for Lutjanus malabaricus, for all seasons combined

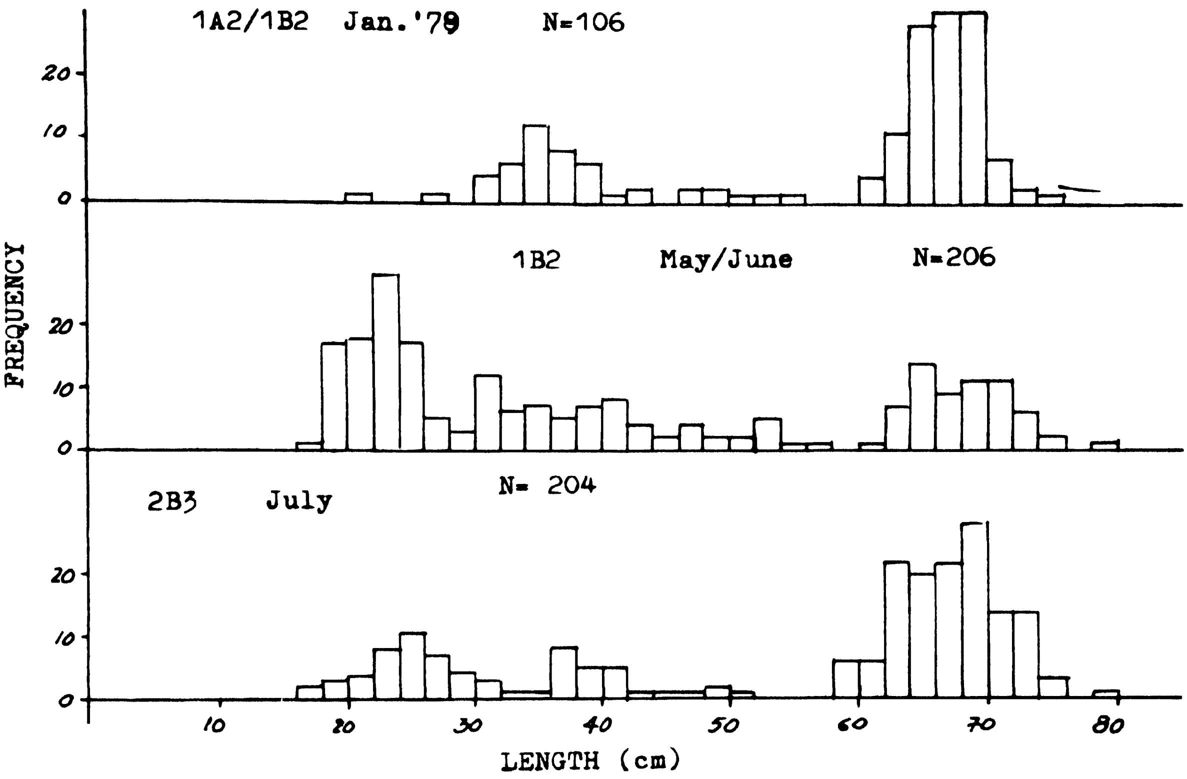


Fig. 2.11 Length frequency distribution for Lutjanus malabaricus

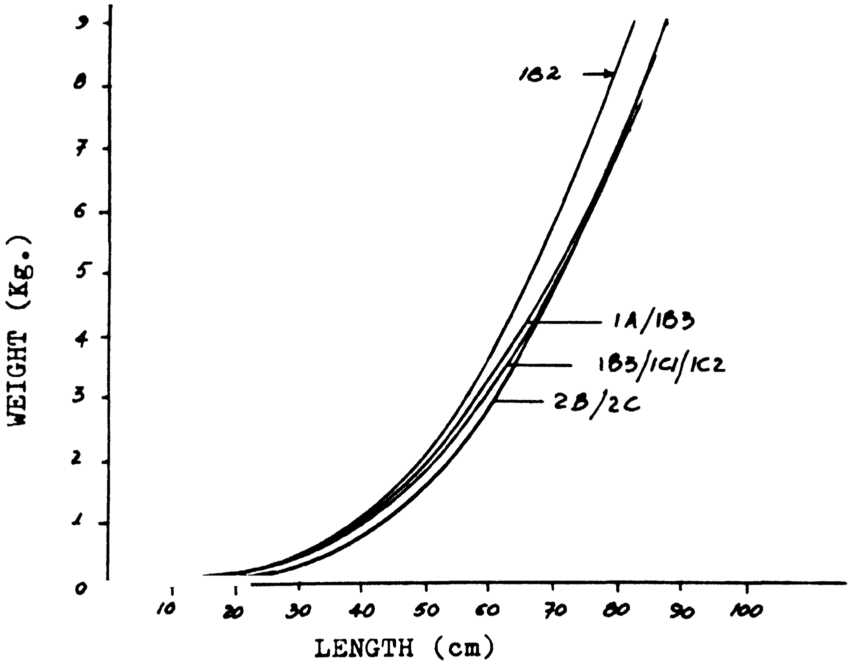


Fig. 2.12 Length-weight relationship for Lutjanus malabaricus

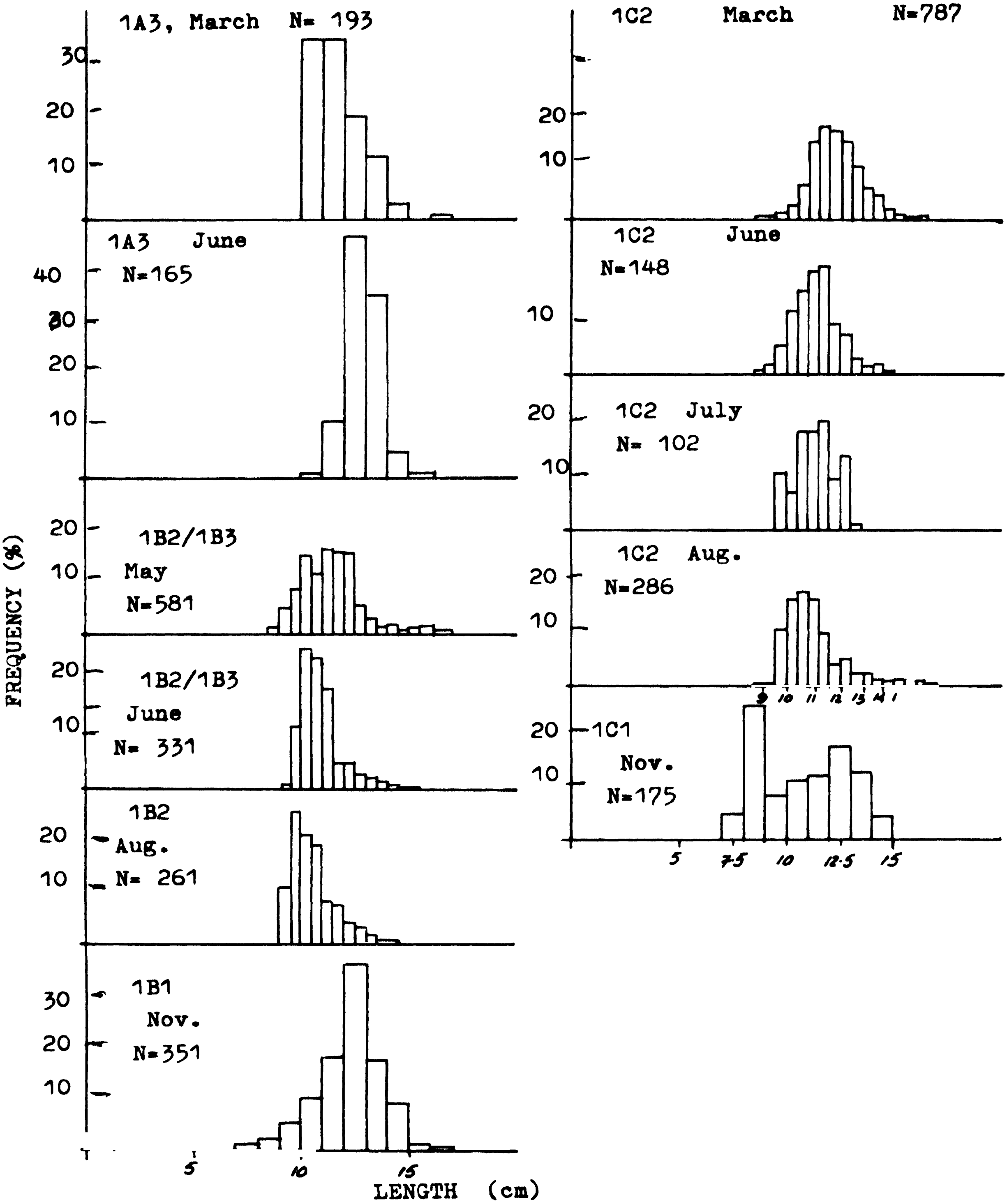


Fig. 2.13 Length frequency distribution for Upeneus sulphureus

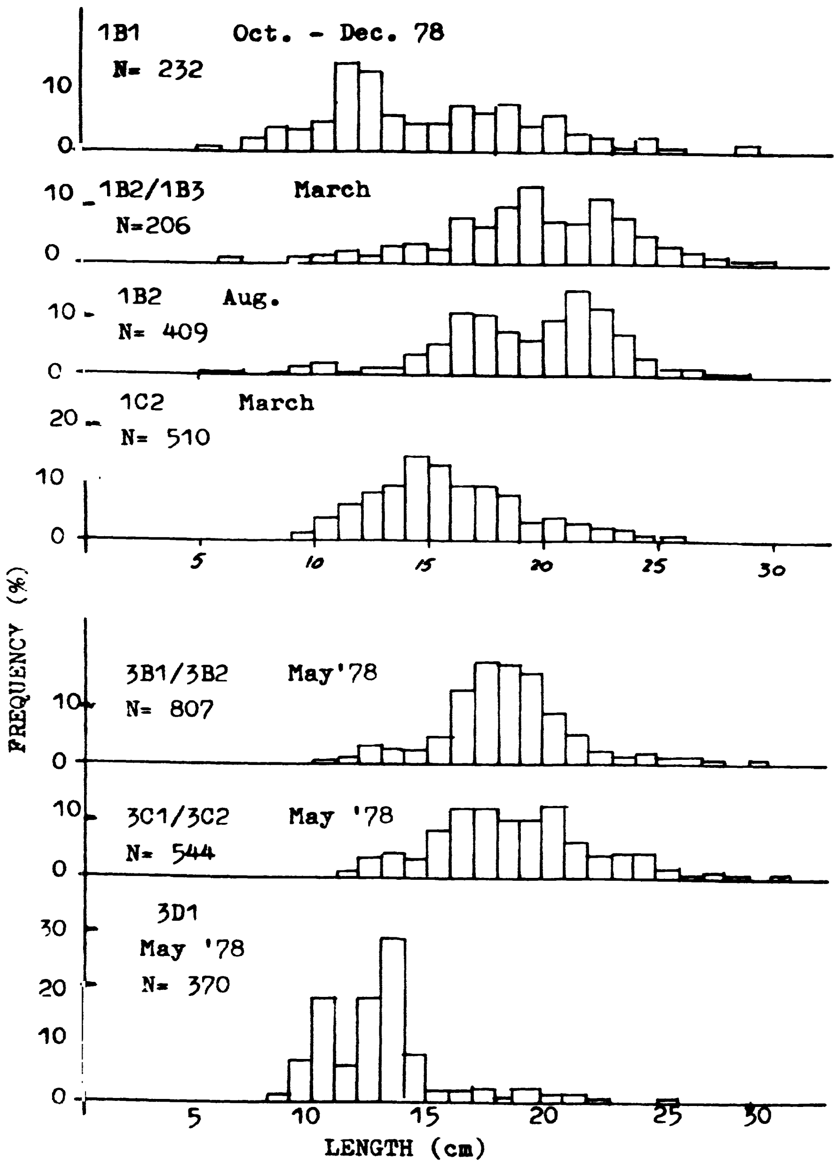


Fig. 2.14a Length frequency distribution of Nemipterus japonicus

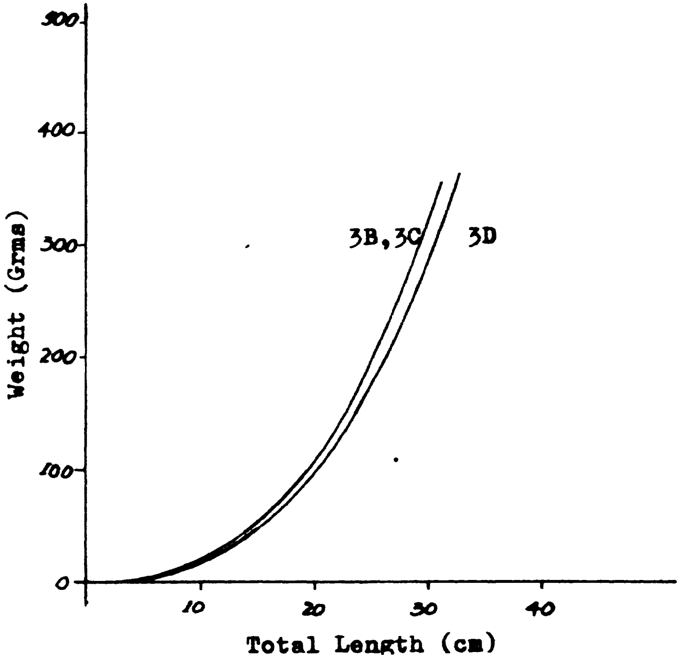


Fig. 2.14(b) Length-weight relationship for Nemipterus japonicus

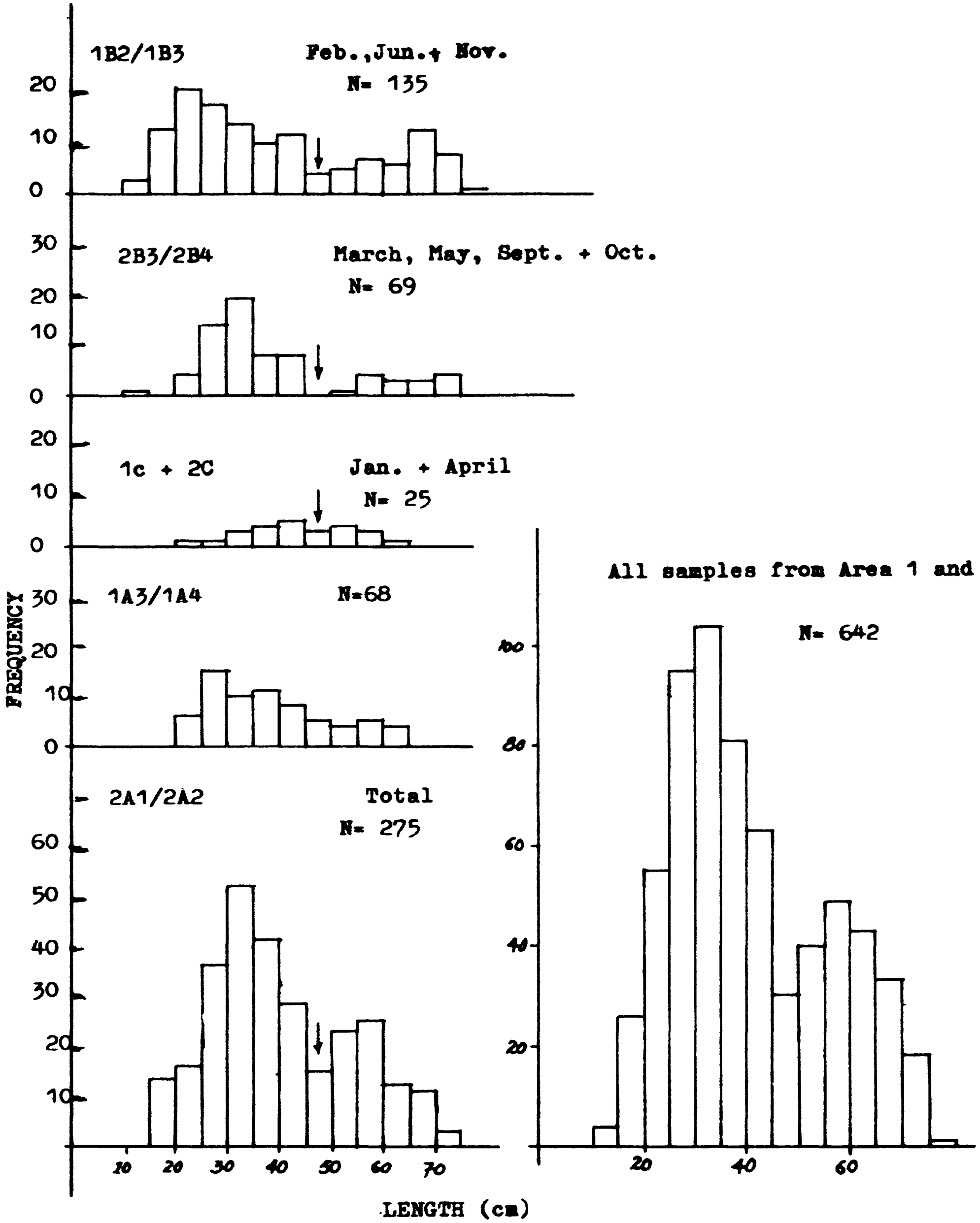


Fig. 2.15 Length frequency distribution for Plectorhincus pictus

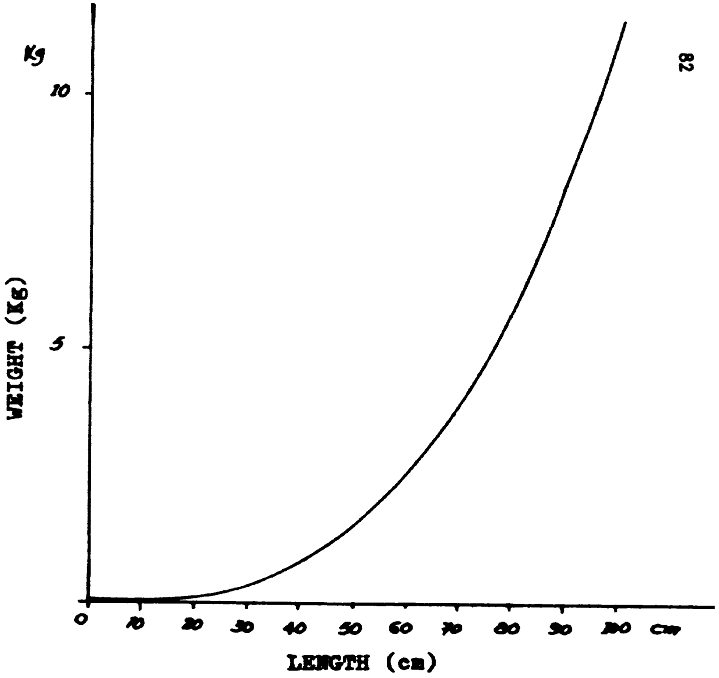


Fig. 2.16 Length-weight relationship for Plectorhincus pictus

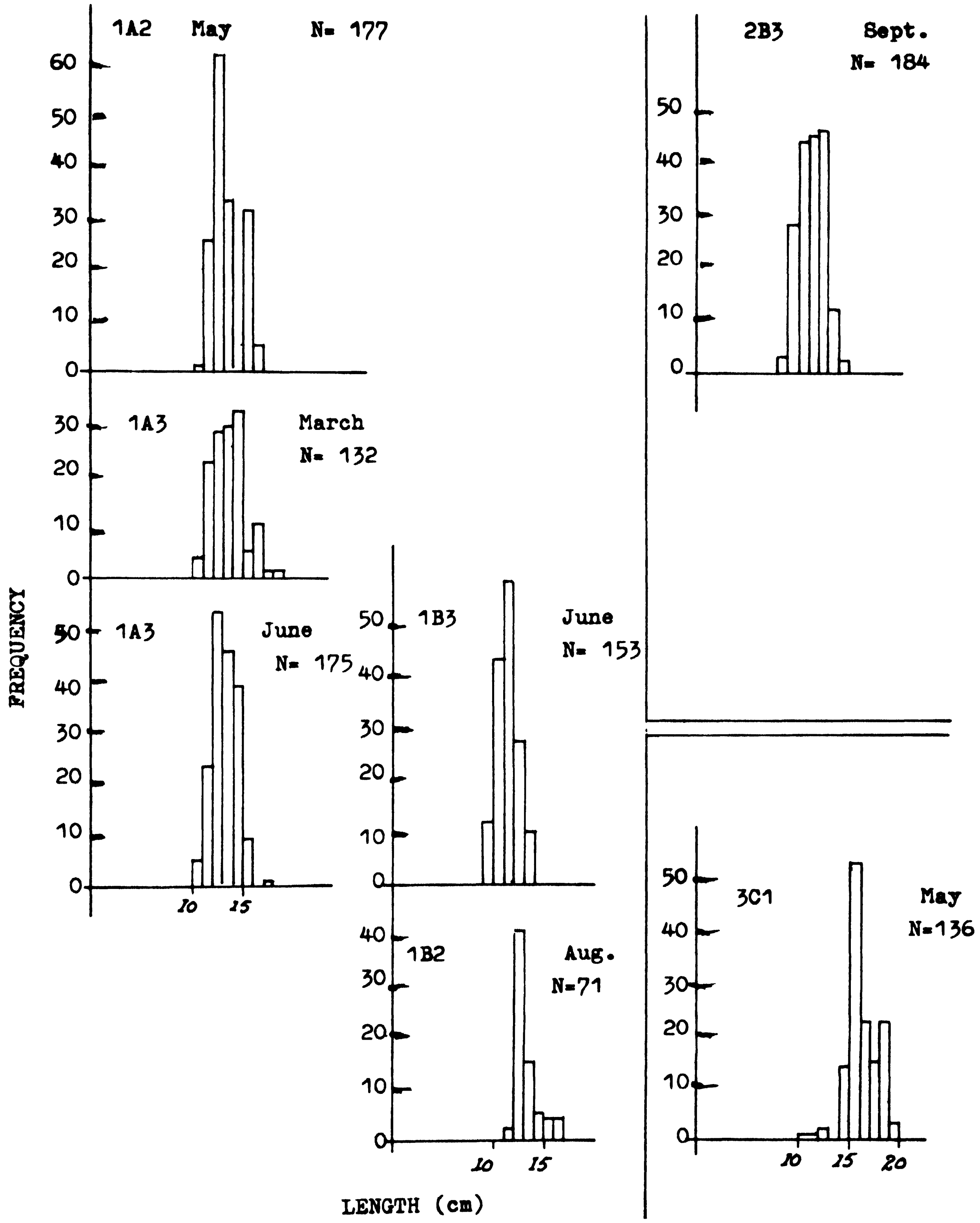


Fig. 2.17 Length frequency distribution for Rhonciscus stridens

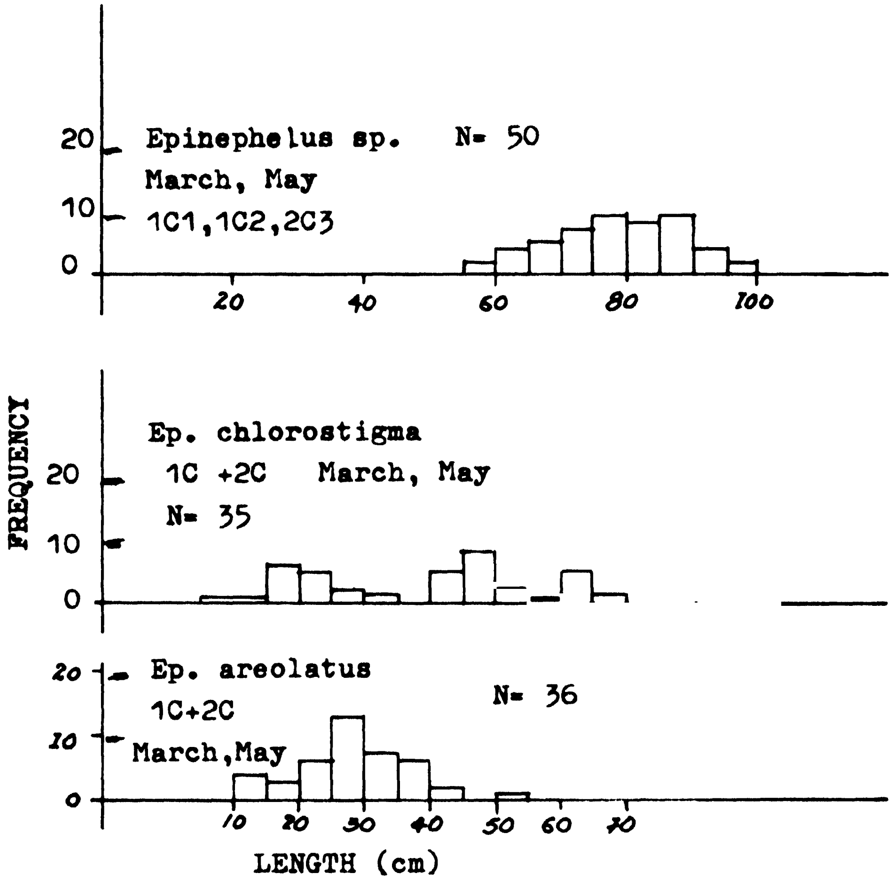


Fig. 2.18 Length frequency distribution for Epinephelus species

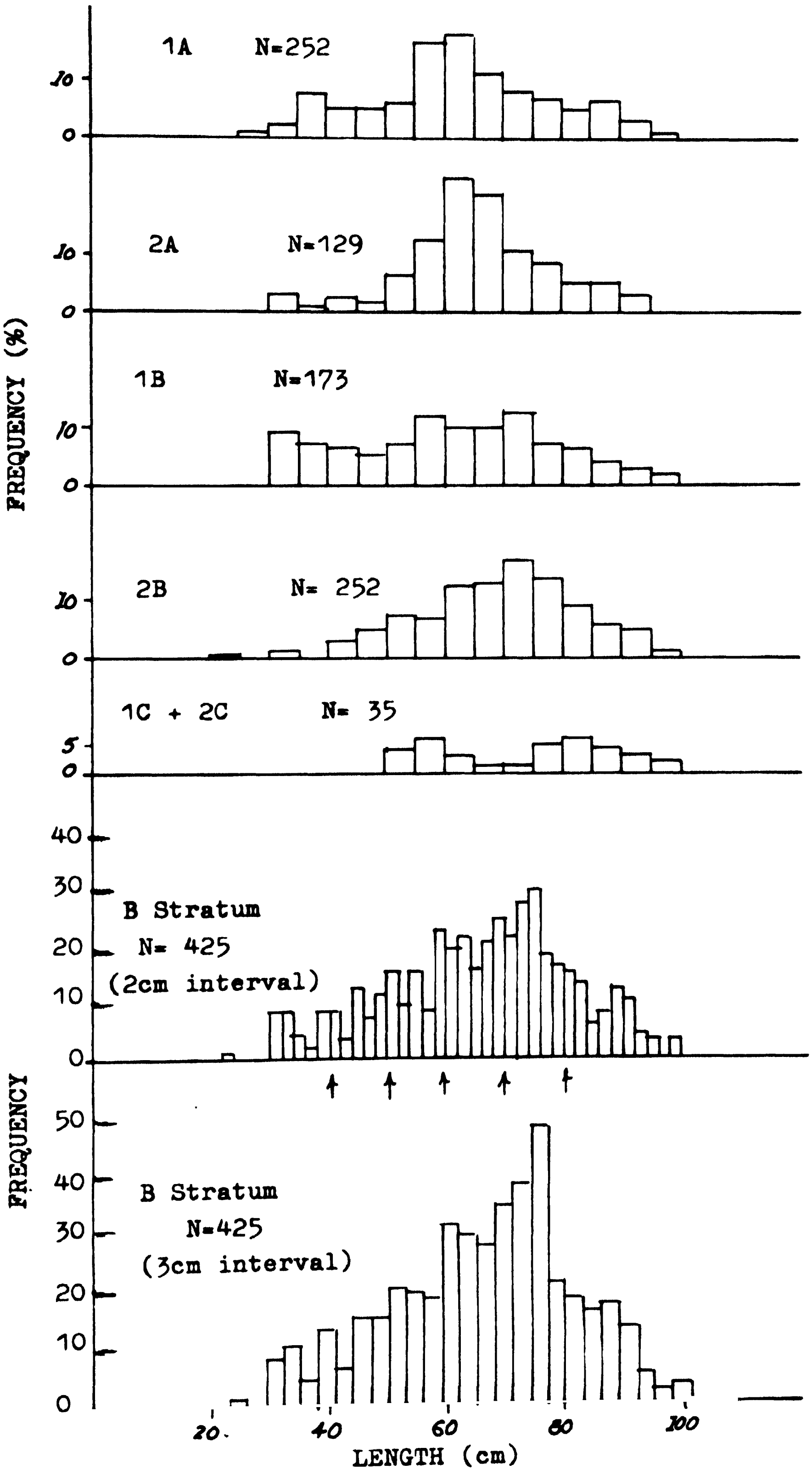


Fig. 2.19 Length frequency distribution of E. tauvina

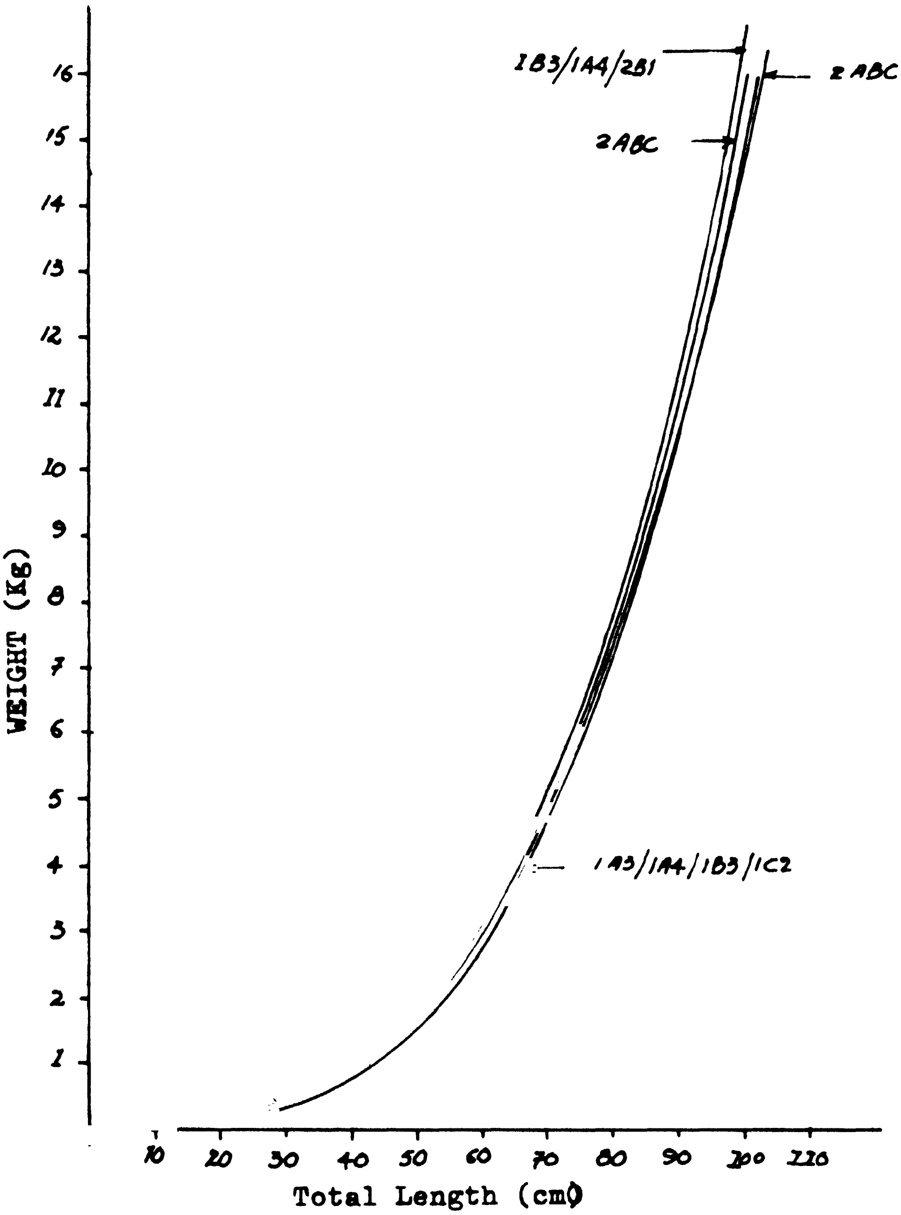


Fig. 2.20 Length-weight relationship of E. tauvina

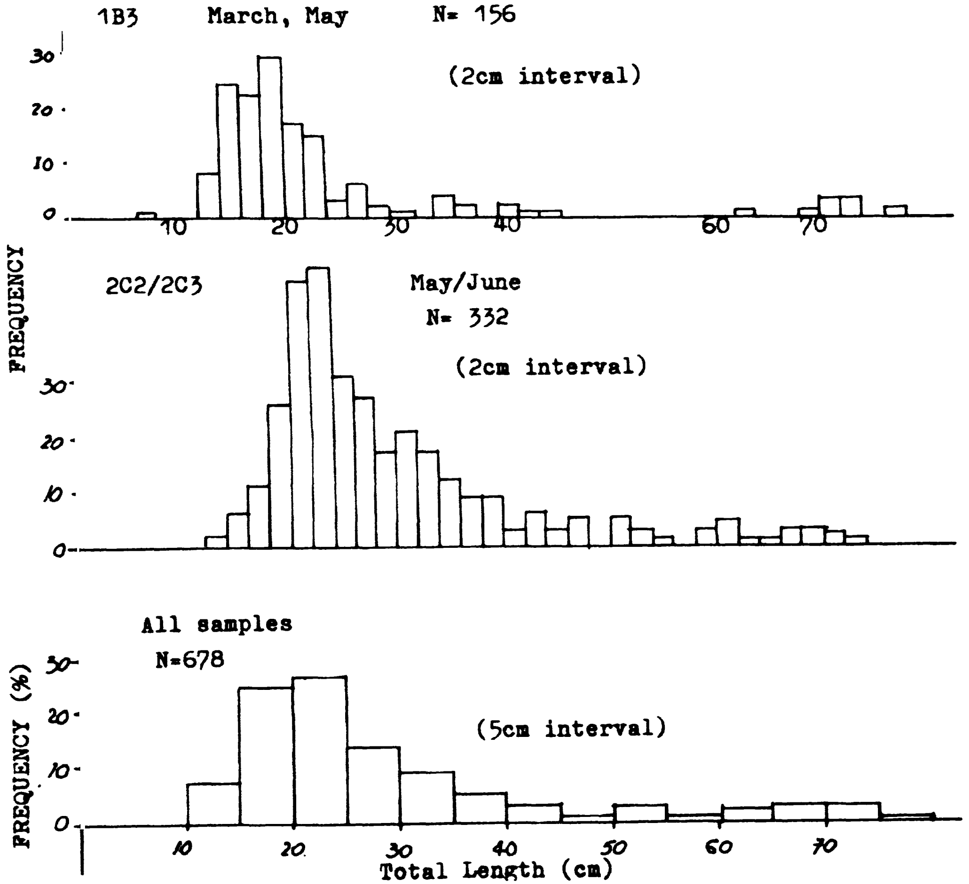


Fig. 2.21 Length frequency distribution of Argyrops spinifer

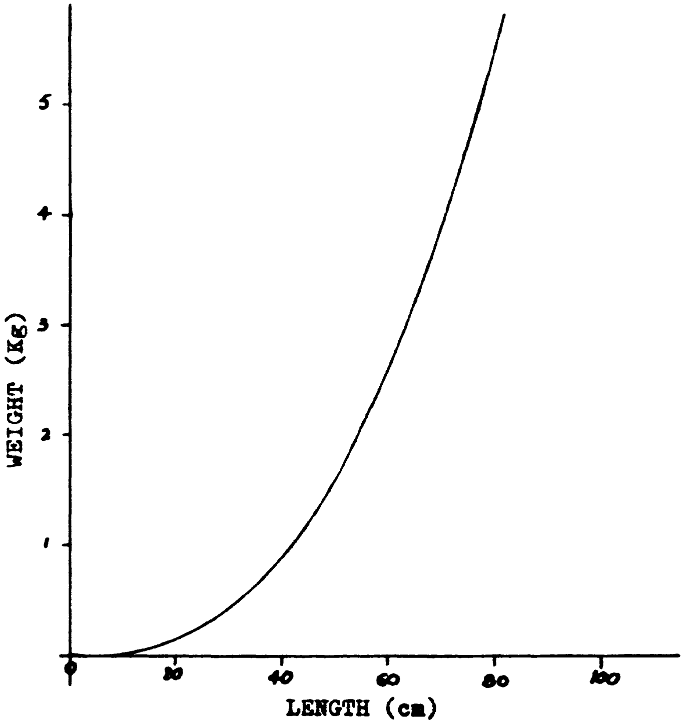


Fig. 2.22 Length-weight relationship for Argyrops spinifer

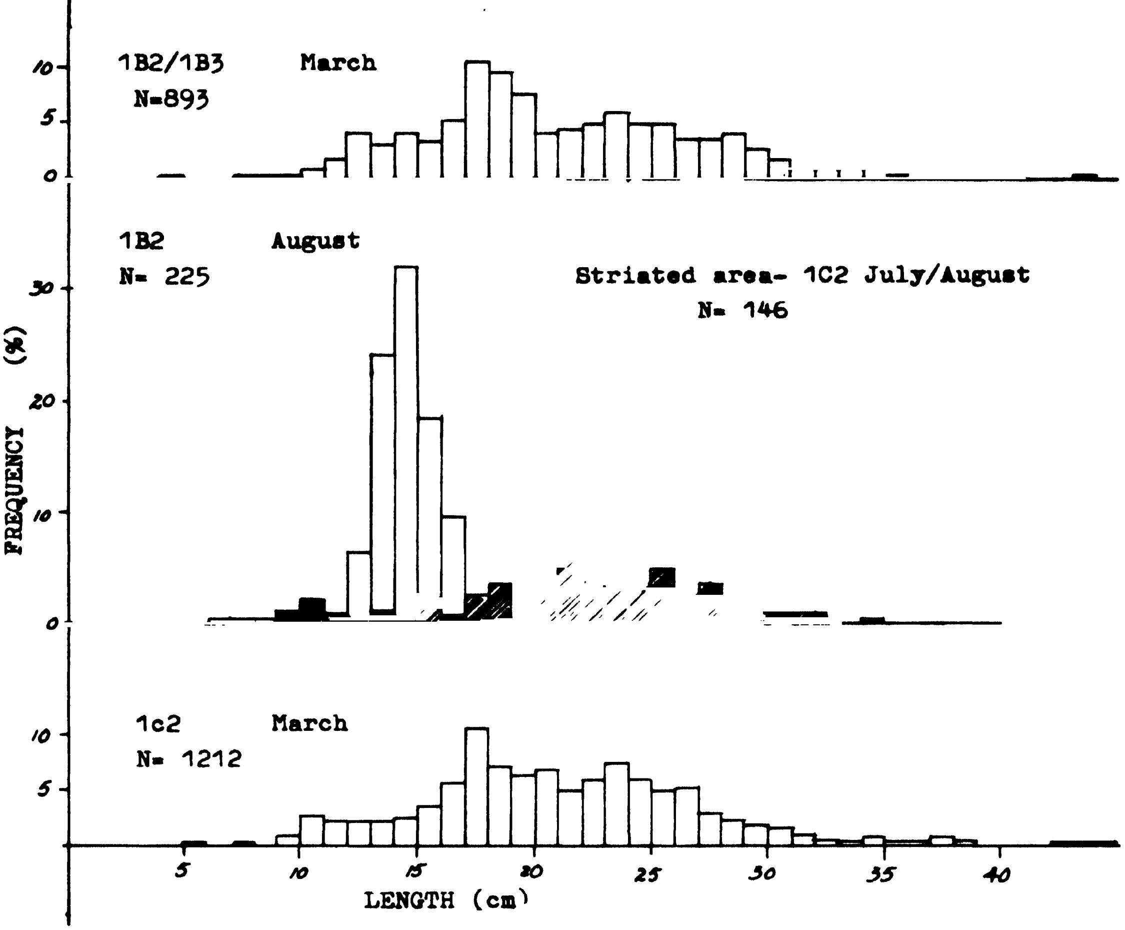
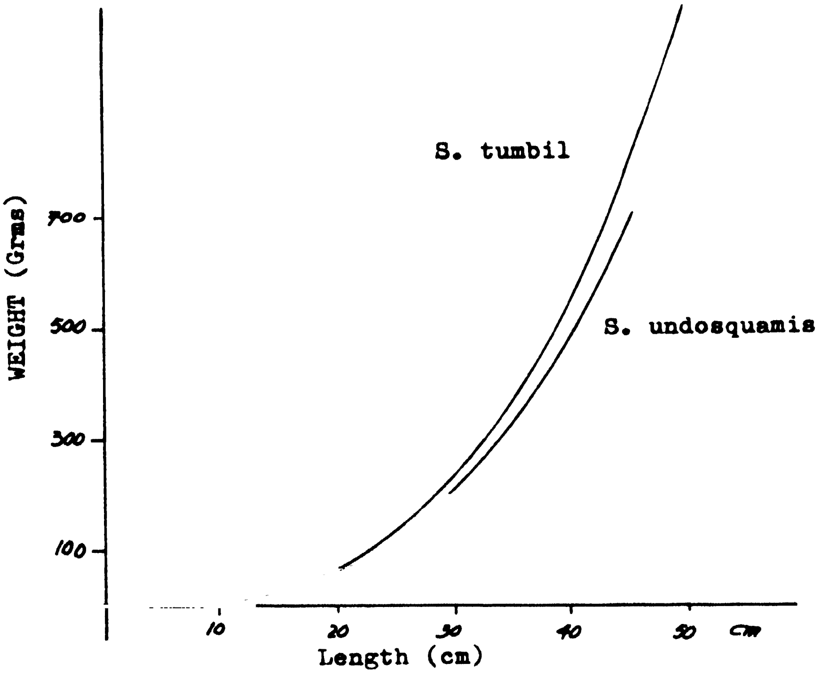


Fig. 2.23 Length frequency distribution for Saurida undosquamis



Part 3

REVIEW OF EXPLORATORY TRAWLING INVESTIGATIONS AND COMMERCIAL FISHING VENTURES IN THE GULFS

by

M. Yesaki
Fishery Biologist

It was considered useful to review the available information on exploratory trawling investigations and also the commercial fishing ventures in the project area, to provide background material for the demersal resources survey undertaken by the Regional Fishery Survey and Development Project. The information thus obtained will supplement the results of the survey and also help to confirm some of the findings. It must be mentioned that this report does not cover all the exploratory and commercial fishing activities in the project area, both in the past and at present and it includes only information which was accessible to the author.

3.1 GULF BETWEEN IRAN AND THE ARABIAN PENINSULA

3.1.1 Fishing Vessel RASHGOO

The Iranian Government through the Danish Foreign Ministry contracted in 1936 a Danish team, comprised of biologists and fishermen, to conduct a fishery survey off the coast of Iran. This survey was completed in two phases during the periods February-April 1937 and January-April 1938. During this survey, a total of 154 drags with trawls and 12 drags with danish seines were completed, principally along the entire coast of Iran from Bandar Shahpur at the head of the Gulf of Chanhbor near the Pakistan border. A few drags with trawls also were completed in the central and Arabian side of the Gulf.

A comprehensive report of the fishes found in the Gulf during this survey has been published by Blegvad and Løppenthin (1944). In this report, the authors give coordinate, time, depth and bottom type of the fishing stations. They described the principal characteristics of all species captured and the numbers of each species captured in a particular drag. They also made general comments of average size, commercial significance and palatability of many of the species. They did not include in this report, however, particulars of the trawl or ancillary fishing equipment and the duration of the drags.

Blegvad and Løppenthin identified 172 species belonging to 61 families of fishes in the catches of the 151 trawl drags conducted off the coast of Iran. Fig. 3.1 shows the frequency of capture of 148 different species or species groups. Of these groups, 39 were caught only once, 11 twice and 10 three times. Only 24 groups were caught 20 times or more.

3.1.2 Fishing Vessel NEW HOPE

An FAO masterfisherman conducted a cursory exploratory fishing survey for shrimp off Iran from May to mid-July 1955. A total of 46 drags were completed during this survey, principally in the area between the eastern end of Quehm Island and Bandar Abbas (Fig. 3.2). This shrimp survey was conducted with the NEW HOPE a vessel of 11.6 m LOA, 3.5 m beam and 1.5 m draft. The nets were shrimp trawls constructed of cotton webbing and measured 16.5 m on the footrope. These nets were fished with 1.2 m otter boards and 18.0 m sweeplines. The areas fished, the vessel and fishing gear used and the results of explorations are described in a report by Fibiger and Frederiksen (FAO/UN, 1957).

A fishing log with total catch of fish and shrimp is given in the report of Fibiger and Frederiksen. The results of 42 drags is summarized in Table 3.1. Catch rates of fish and shrimp were low in the depth intervals investigated but considerably lower in the deeper interval. The dominant fish species were specified in the text to be Leiognathidae, Engraulis vitrirostris and small Ilisha indica. Many species of Pomadasyidae, Sciaenidae, Mullidae, Sparidae, Ephippidae, Polynemidae, etc., were caught in small quantities, but rarely were large specimens of these families captured during this survey.

Table 3.1

CATCH PER HOUR RATES OF FISH AND SHRIMP OBTAINED BY THE F/V NEW HOPE

Depth interval (m) Number of drags	0-24 37		25-49 5	
Catch	kg	kg/h	kg	kg/h
Fish	1 385	37.4	55	T
Shrimp	120	3.4	11	0.0

3.1.3 Fishing Vessels TATSUTA MARU and SHINANO MARU

About 1954, the Southern Fisheries Development Company, an affiliate of the Nippon Mining Company, a big Japanese firm with fishing interests, formed a joint venture with the Iranian Government. This agreement permitted a Japanese vessel with all Japanese crew to fish off the Iranian coast and to sell the catch in this country in return for a percentage of the profits. This joint venture with the Persian Gulf Fish Company was terminated in late 1960 (Keddie, 1971). However, in about 1963, the Southern Fisheries Development Company entered into another joint venture with a private company. A vessel of this Japanese company operated periodically in Iranian waters under this joint venture until about 1968.

The TATSUTA MARU operated intermittently off the Iranian coast from 1954 to about 1964 and the SHINANO MARU from about 1966 to 1968. These vessels were side trawlers of approximately 550 gross tons. The nets used by these vessels measured 39.0 m on the headrope and 54.0 m on the footrope. The TATSUTA MARU completed drags of 1 3/4 to 2 hours' duration at speeds of approximately 3.5 knots. Fishing was conducted during the day and generally continued through the night (S. Tahara, FAO masterfisherman, personal communication).

The landings of the TATSUTA MARU for the period 1956 through 1962 and of the SHINANO MARU for the 1966-1976 fishing seasons were available for analysis (S. Tahara, FAO masterfisherman, personal communication). This information is summarized in Table 3.2, which shows that the Southern Fisheries Development Company vessels produced from 4.3 to 6.4 t/d of marketable fish during this period.

Detailed species composition of the landings was available for the 1955-56 and 1966-67 fishing seasons. Table 3.3 shows there was little change in species composition of the landings during this 10-year interval. Pomadasys argenteus was the most abundant species and accounted for roughly one-third of the landing. Carangidae was the second and third most abundant group during the 1955-56 and 1966-67 fishing seasons, respectively. Lutjanidae and Sciaenidae were respectively the fourth and fifth most abundant groups during these two fishing seasons. There were notable changes only in the landings of Scomberomorus commerson and Nemipteridae. S. commerson increased in importance from seventh place in 1955-56 to second place in 1966-67, whereas Nemipteridae decreased in importance from third to ninth during these respective fishing seasons.

Seasonal fluctuations in the availability of commercial species were determined by comparing catch rates for the various cruises conducted during the 1955-56 fishing season (Table 3.4). Total catch rates were high (1 164 kg/drag) at the commencement of the fishing season in October-November, but decreased markedly to the lowest levels in December (493 kg/drag) and January-February (594 kg/drag). Thereafter, total catch rates increased progressively through March (1 082 kg/drag), March-April (1 401 kg/drag), April-May (1 495 kg/drag) to highest levels at the end of the fishing season in June (1 797 kg/drag). Catch rates of the individual species or groups followed more or less this pattern of lowest availability during winter and highest availability during late spring.

Catches of cruises 1 to 4 were lumped, as were those of 5 to 7, to determine average catch rates for the cool and hot seasons, respectively. Catch rates for the TATSUTA MARU averaged 822 kg/drag from November to March, versus 1 548 kg/drag for April to June.

The average total catch per day rate for the 1955-56 season (5 140 kg/day) is not significantly different from the overall average daily rate for the six fishing seasons (5 481 kg/day) for which data was available. Therefore, the average total catch per haul rate of 1 053 kg, realized by the TATSUTA MARU during 1955-56 is probably a good indice of commercial fish abundance available to capture by 550 gross ton side trawlers off the coast of Iran.

Table 3.2

CATCH PER DAY RATES OF MARKETABLE FISH OBTAINED BY VESSELS OF THE SOUTHERN FISHERIES DEVELOPMENT COMPANY

Period	No. of days fished	Landings (kg)	kg/day
XI, 1954-VII, 1955	102	?	?
IX, 1955-VIII, 1956	152	781 329	5 140
XI, 1956-VIII, 1957	115	490 984	4 269
I, 1958-VII, 1958	92	417 347	4 536
IX, 1958-VII, 1959	172	1 043 699	6 068
IX, 1960-XII, 1960	40	256 325	6 408
?, 1966-?, 1967	158	1 005 690	6 365
Total	729 1/	3 995 371	5 481

1954-62, F/V TATSUTA MARU
1966-67, F/V SHINANO MARU

1/ Does not include days fished during 1954-55

Table 3.3

SPECIES COMPOSITION OF LANDINGS BY SOUTHERN FISHERIES DEVELOPMENT COMPANY VESSELS DURING TWO FISHING SEASONS

Vessel: Period:	TATSUTA MARU 1955-56		SHINANO MARU 1966-67	
Species	Landings (kg)	Percent	Landings (kg)	Percent
Pampus argenteus	19 746	2	10 323	1
Lutjanidae	70 294	9	119 549	12
Pomadasys argenteus	254 482	33	316 803	32
Nemipteridae	113 682	15	9 552	1
Scomberomorus commerson	27 156	3	164 960	16
Sciaenidae	43 541	6	100 756	10
Carangidae	142 193	18	124 251	12
Sphyraena sp.	5 047	1	4 939	0
Saurida sp.	17 338	2	14 238	1
Clupeidae	30 360	4	36 778	4
Others	57 497	7	103 541	11
Total	781 326	100	1 005 690	100

3.1.4 Various USSR Vessels SRTM's, RTM LESNOI and PPR VAN GOGH

Vessels of the Azov-Black Sea Research Institute of Marine Fisheries and Oceanography (AzcherNIRO) fished the Gulf in 1956 and again during the 1965-68 interval. The USSR operations in the Gulf included commercial fishing for shrimp with up to seven SRTM's (side trawlers of 929 gross tons), exploratory fishing for bottomfish by the RTM LESNOI (stern trawler of 2 435 gross tons) and simulated production fishing for bottomfish by the PPR VAN GOGH.

The commercial shrimp fishing operations of the SRTM's extended from September through April during the 1965-67 period. The overall catch of these vessels for the three year period was comprised of 23.1% shrimp, 10.7% marketable fish and 66.2% industrial fish.

The LESNOI conducted explorations for bottomfish throughout the Gulf during June-July 1968. This vessel attained average catch rates of 550 kg/h marketable fish and 1 075 kg/h industrial fish in the northern Gulf (west of 52° E. long.). In the southern Gulf (between 52° and 55° E. long.), the average catch rate of marketable fish was lower (408 kg/h), but of industrial fish was considerably higher (1 826 kg/h).

The predominant species in the marketable fish category for the northern Gulf were *Nemipterus japonicus*, *Saurida tumbil*, *Tachysurus dussumieri*, *Otolithes ruber*, *Johnius soldado*,

Table 3.4

CATCH RATES (kg/drag) OF PRINCIPAL SPECIES OBTAINED BY THE TATSUTA MARU DURING THE 1955-56 FISHING SEASON

Cruise number	1	2	3	4	5	6	7	1-7
Period	X/16-XI/20	XII/10-XII/31	I/13-II/14	III/1-III/13	III/29-IV/16	IV/26-V/23	VI/9-VI/25	X/1955-VI/1956
Number of days fished	30	20	30	13	14	28	17	142
Number of hauls	155	114	158	79	65	109	62	742
Pampus argenteus	66	32	27	17	3	8	2	27
Lutjanidae	-	1	42	98	282	242	180	95
Pomadasys argenteus	528	67	117	429	497	572	289	343
Nemipteridae	43	45	99	189	230	281	415	153
Scomberomorus commerson	8	20	72	52	49	19	45	37
Sciaenidae	250	30	4	-	-	4	5	59
Carangidae	82	64	175	246	295	294	386	191
Sphyraena	-	3	5	-	-	12	41	7
Saurida sp.	18	22	1	23	6	18	126	23
Clupeidae	105	77	13	-	-	-	52	41
Others	64	131	31	23	36	43	254	74
Shrimp	-	1	8	5	3	2	2	3
Total	1 164	493	594	1 082	1 401	1 495	1 797	1 053

Selar crumenophthalmus and Decapterus kiliche, whereas in the southern Gulf the dominant species were N. japonicus, N. tolu, S. tumbil, T. dussumieri, Lethrinus miniatus and L. nebulosus. Dominant species in the industrial fish category for the northern Gulf was Leiognathus daurus and Rhonciscus stridens in the southern Gulf.

Simulated production fishing was conducted by the VAN GOGH off Bushire and Ras-al-Mutaf in the northern Gulf from December 1966 through March 1967. This vessel, fishing off Bushire, achieved catch rates of 3.0-3.5 t/day of N. japonicus, S. tumbil and T. dussumieri, the principal food fish. Industrial fish catches as high as 16 t/drag of mixed Leiognathus daurus and Mene maculata and 5 t/drag of Trichiurus lepturus also were made in this area.

From the results of these investigations, the Soviets concluded that daily catch rates of 5 t of marketable fish and an unspecified quantity of industrial fish for fishmeal could be obtained in the Gulf. They further concluded that these catch rates were not economically attractive for heavy displacement trawlers and that, except for shrimp, the Gulf was of no great interest to the Soviet fishing fleet.

3.1.5 Research Vessel UMITAKA MARU

During December 1968 the University of Tokyo, in cooperation with the Kuwait Institute of Scientific Research (KISR) conducted a cursory fishery-oceanography survey with the UMITAKA MARU in various areas of the Gulf (Fig. 3.2). Fishing gears used during this survey included the shrimp trawl, beam trawl, trammelnet and longline. The trawl was fished at eight locations off the coast of Kuwait and at eight locations between the coasts of the Qatar Peninsula and the United Arab Emirates.

The fishes caught during this survey have been described in a book (Kuronuma and Abe, 1972) and the results of oceanographic and biological observations have been analysed by various authors in a summary report (Kuronuma, 1974). A description of the fishing gears used during this survey is included in the latter report. The trawl was a four-panel net constructed of small mesh webbing, 60 mm stretch mesh measure in the wings and 42 mm stretch mesh webbing in the codend. This trawl measured approximately 22.0 m on the headrope and 30.0 m on the footrope. These figures were calculated by assuming 20 percent for hanging times the stretch mesh lengths along the upper and lower margins of the net (M. Wakamatsu, FAO Masterfisherman, personal communication). Otter boards were attached directly to the net and connected to a simple towing warp with 20 m bridles.

In the 16 trawl drags completed by the UMITAKA MARU (Kuronuma, 1974), 142 species belonging to 64 families of fishes were captured. There were marked differences in species diversity in the area off Kuwait from that in the area between the Qatar Peninsula and the United Arab Emirates (Fig. 3.1). Relatively few species were captured in the former area, of which a relatively high percentage (40%) was captured in more than two drags. On the other hand, many species were captured in the latter area, of which a relatively low percentage (23%) was captured in more than two drags.

The Arabian side of the Gulf is probably richer in numbers of species than the Iranian side because of the greater diversity of habitats. The bottom condition off the coast of Iran is predominantly mud and smooth. A maze of sand, gravel, rock and coral outcroppings constitutes the bottom condition along much of the Arabian side of the Gulf.

The Gulf is relatively rich in numbers of species, but most of the species are of small size. The length range of the 31 most abundant species (by weight) captured by the UMITAKA MARU is given in the report by Kuronuma (1974). Only six of these species attained lengths of 25 cm or more.

The principal fish families caught by the UMITAKA MARU during December 1968 in Kuwait territorial waters and in the waters between the Qatar Peninsula and the United Arab Emirates coast is given in Table 3.5. The catch rate for the latter area was 49.7 kg/h and for the former area was 93.1 kg/h. The low rate for Kuwait territorial waters may have resulted from decreased availability of demersal fish due to seasonal fluctuations and/or cropping by vessels fishing shrimp in this area.

3.1.6 Research Vessel EL HADITH

The Kuwait Government vessel EL HADITH was commissioned in December 1968 for training and experimental fishing. This vessel was designed basically as a stern trawler, but also for use as a purse seiner and gillnetter. Exploratory fishing was conducted by this vessel in Kuwait territorial waters with modified 18.0 m shrimp trawls attached directly to otter boards (Fig. 3.2).

The results of 51 drags completed by the EL HADITH in Kuwait territorial waters during August-September 1969 is given in an appendix table in the report of Meschkat (FAO, 1970), and is summarized in this report in Table 3.6. The contributions of marketable fish, industrial fish and shrimp were 10%, 81% and 9% respectively, of the total catch. Small Pomadasys sp. and other perciform fish constituted the bulk of the industrial fish component.

3.1.7 Fishing Vessel GAZELLE

The Government of Qatar purchased a stern trawler in 1975 and has subsidized the operations of this vessel in an attempt to increase the production of fish in the country. The Qatar National Fishing Company provides shore support for the GAZELLE, which has operated from July 1975 to the present, with only occasional stoppages. This vessel makes short trips of generally 4-5 days duration along the Arabian side of the Gulf, principally in the area between the Qatar Peninsula and the United Arab Emirates coast. Fishing is conducted only during the daylight hours. The net fished by this vessel is a high-opening bottom trawl designed for a stern trawler with 600 HP main engine. This net is constructed throughout of nylon webbing, 200 mm in the wings and 40 mm in the codend. Codends of larger meshed webbing have been used, depending upon the preference of the various captains. Headrope and footrope of this net are 34.0 m and 39.0 m long respectively.

The GAZELLE had conducted 58 trips from July 1975 to March 1977. Records of operations and catch have been kept since initiation of fishing and are on file in the Fisheries Division of the Ministry of Industry, Agriculture and Fisheries. These records were kindly made available to the author and the summary reports of 48 trips made during the period November 1975 to March 1977 were examined. Information given in these reports included dates at sea, total hours fished, total catches of marketable fish landed and industrial fish discarded. These summary reports were analysed to determine general production rates and seasonal fluctuations in availability of marketable industrial fish. Results of this analysis are given in Table 3.7.

Table 3.5

CATCH RATES (kg/h) OF THE PRINCIPAL FAMILIES CAPTURED BY THE UMITAKA MARU OFF KUWAIT AND BETWEEN THE QATAR PENINSULA AND THE UAE COAST (FROM KURONUMA, 1974)

In Kuwait territorial waters		Between Qatar Peninsula and UAE coast	
Species	kg	Species	kg
Nemipteridae	78.8	Carangidae	63.8
Mullidae	44.7	Mullidae	59.9
Sharks and rays	40.1	Clupeidae	19.8
Synodontidae	18.4	Synodontidae	16.8
Leiognathidae	12.3	Leiognathidae	12.1
Sciaenidae	10.4	Pomadasyidae	11.6
Tetradontidae	7.1	Nemipteridae	9.6
Serranidae	6.2	Sharks and rays	5.6
Polynemidae	4.4	Lethrinidae	4.7
Platycephalidae	3.9	Ariidae	3.2
Others	22.4	Others	118.8
Total catch	248.7	Total catch	325.9
Catch rate (kg/h)	49.7	Catch rate (kg/h)	93.1

Table 3.6

CATCH AND CATCH RATES (kg/h) OBTAINED BY THE EL HADITH DURING SEPTEMBER-OCTOBER, 1969 IN KUWAIT TERRITORIAL WATERS

Number of drags	51		
Number of hours	102		
Catch	kg	kg/h	Percent
Marketable fish	1 073.5	10.5	10
Industrial fish	8 143.0	79.8	81
Shrimp	879.5	8.6	9
Total	10 097.0	98.9	100

Table 3.7

CATCH AND CATCH RATES OF MARKETABLE AND INDUSTRIAL FISH OBTAINED BY THE GAZELLE DURING THE COOL AND HOT SEASONS

Season	Cool (XI-75/III-76)		Hot (IV-VII-76)		Cool (X-76/III-77)		Cool + Hot	
Number of trips	14		11		23		48	
Number of hours	349h 15min		282h 45min		412h 0 min		1 043h 0 min	
Catch	kg	kg/h	kg	kg/h	kg	kg/h	kg	kg/h
Grouper (*Epinephelus* sp.)	11 175	32.0	6 880	24.3	10 028	24.3	28 083	26.9
Large emperor (*Lethrinus* sp.)	7 400	21.2	3 960	13.9	10 380	25.2	21 740	20.8
Small emperor (*Lethrinus* sp.)	15 640	44.8	16 880	59.7	19 354	47.0	51 874	49.7
Goatfish (Mullidae)	6 506	18.6	2 163	7.7	4 051	9.8	12 720	12.2
Other marketable fish	35 390	101.3	17 295	61.2	31 734	77.0	84 419	80.9
Industrial fish	66 047	189.1	70 170	248.2	87 450	212.3	223 667	214.5
Total	142 158	407 0	117 348	415 0	162 997	395 6	422 503	405.0

During the 17 month period, the GAZELLE averaged 405 kg/h of total fish, of which 47 percent was marketable fish and the remainder industrial fish. Total catch rates were slightly higher during the hot season because of the greater availability of industrial fish. Catch rates of marketable fish were lower during the hot (166.8 kg/h) than during the cool season (201.6 kg/h).

The overall catch of marketable fish for the 17 month period by the GAZELLE was comprised of 37% *Lethrinus* sp., 14% *Epinephelus* sp., 6% Mullidae and 43% unsorted.

Fishing logs of the GAZELLE for the period October-December 1976 and February-March 1977 were available for analysis. Fishing drags for which position coordinates were noted were tabulated by 15 minute square areas to determine the grounds fished by this vessel. Figure 3.3 shows the GAZELLE restricted fishing to a narrow band immediately inside the 38 m isobath (20 fath) from the Qatar Peninsula across to the coast of UAE. However, most (75 percent of fishing drags) of the effort during the period examined was expended in the area north, northwest, southwest and south of Halul Island.

3.2 GULF OF OMAN AND NORTH ARABIAN SEA

3.2.1 Fishing Vessels KHASAB, BUKHA and DHALKOT

The Government of the Sultanate of Oman signed a contract with Arabco Limited on 26 June 1975 for a complete fisheries complex. This included the construction of blast freezer, cold storage, ice plant, ice storage and fish processing facilities, as well as gear storage shed, workshop and office. The fisheries complex was completed for inauguration on National Day, 18 November 1976. Also included in this contract was the purchase of three second-hand trawlers. These trawlers were purchased in New Zealand, two of which arrived in Muscat in December 1976 and the third in March, 1977.

The original contract also stipulated that Arabco Limited provide a team of management personnel to manage the fisheries complex and operate the trawlers for one year. A full team of management personnel was installed at the fisheries complex by 9 November 1976. Two of the trawlers commenced fishing operations out of Muscat in December 1976. The third started fishing in March 1977. After the initial year of operations, the Government of Oman renewed the management contract with Arabco Limited to extend through November 1978.

3.2.1.1 Vessels and fishing gear

The three trawlers purchased in New Zealand are identical in dimensions and design. They are 19.8 m LOA, 5.9 m moulded breadth, 3.3 m depth and 2.7 m draft (approximately). They have the wheelhouse forward, with raised forecastle and the workdeck aft. Main engines are rated at 230 HP and are coupled through 3:1 reduction gears and CP propellers. Ancillary fishing equipment includes trawl winches set behind the wheelhouse and net drum on the stern.

The trawlers are equipped with the following electronic navigational and fishing aids: auto-pilot, radar, SSB radio-telephone and white-line echosounder.

Trawlnets of New Zealand design, measuring 28.1 m on the headrope and 32.9 m on the footrope, were used by government trawlers from the commencement of fishing operations to September 1977. Since this date, trawlnets of Norsenet-design have been used, which measured 29.2 m on the headrope and 19.2 m on the footrope. These nets are constructed of 225 mm webbing in the wings, 120 mm webbing in the body and 90 mm webbing in the codend. The sweepline-bridle assemblage consisted of 27 m sweeplines, 27 m single plus 27 m double legs for the upper bridle and 54 m single leg for the lower bridle.

3.2.1.2 Data collection

Regional Fishery Survey and Development Project personnel arrived in Muscat in January 1977 to initiate the demersal trawl survey programme with the R/V DARBAT, the Oman Government vessel participating in the regional survey. While in Muscat preparing the DARBAT for the first cruise, project personnel drafted a fishing log for use on the Government trawlers that had started fishing in December 1976. The information requested on this fishing log included the following:

(a) Name of vessel and skipper
(b) Trip number
(c) Date of departure and return
(d) Length of trawl headrope and footrope
(e) Drag number
(f) Date of drag
(g) Position of drag
(h) Depth and times trawl set, hauled and duration
(i) Catch

This log was mimeographed and copies were sent to the fisheries complex with a covering letter from the Fisheries Department requesting that these be completed during each trip by the skippers of the government trawlers.

The skippers of these vessels have been complying with this request, so that there are fishing logs of most trips completed since January 1977 to the present, on file either in the Fisheries Department or the fisheries complex. Table 3.8 shows the numbers of fishing logs which were examined in the present analysis. These fishing logs accounted for 663 t of the 895 t landed to June, 1978, or 78 percent of landings for the initial 19 month period of operations.

Information given in the fishing logs was generally good. Position of drags was noted either in coordinates or by area, for example: south of Seeb Islands, off Ras Al Jibsh, etc. Detailed information of species composition for each drag was not given in the logs. Instead, catches by drag were noted in numbers of boxes (approximately 30 kg capacity) of marketable fish iced in the hold and on occasion, numbers of boxes of industrial fish dumped overboard.

Detailed records of landings by government trawlers were not kept until July 1977. Since this date, records have been kept of the vessel, date of landing and numbers of boxes (20 kg capacity) of species and species groups off-loaded. The catch was sorted into the following seven categories; emperors (Lethrinus sp.), jacks (Carangidae), grunts (Plectorhynchus sp.), groupers (Epinephelus sp.), cuttlefish (Sepia sp.) and mixed fish. The number of landings for which species composition information was available is shown in Table 3.8.

The fishing logs of government trawlers on file in the Fisheries Department were made available for this analysis by the Director of Planning and Research, whereas the fishing logs and landing statistics on file in the Fisheries Complex were made available by the Director of Projects and Marketing. Personnel of the fisheries complex were most helpful in answering queries and providing information, especially H.N. Riami, R. Purvis and B. Kluzniak.

Table 3.8

NUMBER OF CRUISES FOR WHICH FISHING LOGS AND LANDINGS WERE AVAILABLE FOR ANALYSIS

Year	Month	Vessel					
		KHASSAB		BUKHA		DHALKOT	
		Fish log	Species Composition	Fish log	Species Composition	Fish log	Species Composition
1976	December	0	0	0	0	0	0
1977	January	6	0	5	0	0	0
	February	11	0	0	0	0	0
	March	3	0	1	0	2	0
	April	2	0	0	0	0	0
	May	1	0	1	0	2	0
	June	0	0	4	0	5	0
	July	2	1	5	5	6	6
	August	7	7	3	3	5	5
	September	4	4	3	4	4	4
	October	4	4	4	5	5	5
	November	2	2	1	0	3	2
	December	1	1	5	8	0	2
1978	January	4	4	5	5	0	0
	February	3	3	1	2	2	3
	March	2	2	4	4	1	1
	April	1	1	1	2	3	3
	May	3	3	3	3	3	3
	June	2	0	2	0	1	0
	Total	58	32	48	39	42	34

3.2.1.3 Methods of analysis

All available fishing logs for the period from January 1977 to June 1978 were examined for monthly total catch rates on the various fishing grounds. Drags completed on two of the grounds were further segregated into less than, and greater than, 36 m intervals to ascertain bathymetric differences in total catch rates on these grounds.

Available fishing logs, with corresponding landing statistics were combined to determine catch rates of the dominant species groups on the various fishing grounds. Most trips were completed on a single ground, which permitted a straightforward computation of catch rates for the various species groups. During some trips, however, a few drags were completed on one ground and additional drags on another. In these instances, the percentage of total catches from each ground calculated from the fishing logs was used in proportioning the catches of species groups on the different fishing grounds.

Information about the different fishing grounds was gathered through conversations with the Fleet Supervisor and skippers of Arabco Management Group.

3.2.1.4 Fishing grounds

Government trawlers generally restricted fishing operations to four relatively confined localities off the northeast and central coasts of Oman (Figs.3.4 and 3.5). The continental shelf west and northwest of Suwadi ground, as well as between Muscat and the Ras Al Jibsh ground, were infrequently fished by government trawlers for several reasons, including low catch rates of marketable fish and heavy concentrations of stationary artisanal fishing gear. One of the trawlers (DHALKOT) was based in Salalah in May 1978 and completed several trips out of this port. The results of these operations were not considered in the present summary.

Suwadi Ground - This ground extends from Suwadi Point to approximately 16 mi west of this headland and inshore from 25 m to offshore along the 44 m isobath. Bottom sediments on this ground are coarse sand, broken shell and coral, with scattered coral outcroppings.

Seeb Ground - This ground is approximately 33 mi in length and stretches from 3 mi west of Fahl Island to 4 mi west of Clive Rock. The breadth of Seeb ground is limited by the 15 and 77 m isobaths. Bottom type is coarse sand, broken shell and coral, with scattered coral outcroppings.

Sur Ground - This ground is 13 mi long, stretching from Sur to Khor Hajr. Trawling is conducted between the 18 and 55 m isobaths on predominantly mud and sand bottom.

Ras Al Jibsh Ground - This ground extends for 35 mi along the coast, from 25 mi north to 10 mi south of Ras Al Jibsh and offshore of the coast from 15 to 40 m. Bottom sediment on this ground is predominantly mud.

3.2.1.5 Fishing effort

Information for 1 258 valid drags, totalling 2 843.2 hours of trawling, was documented from the available fishing logs. Of this total effort, only 1 percent was expended outside the boundaries of the 4 percent principal fishing grounds. The number of drags and hours of trawling effected on the various grounds is given in Table 3.9 and the distribution of effort (number of hours) by month on the grounds is shown in Fig. 3.6.

Sixty percent of fishing time (1 699.2 h) was expended on the Seeb ground. After the initial months of operations, most of the fishing effort was concentrated on this ground during the months of June though to November, that is, in the southwest monsoon season. Sea conditions west of Muscat are generally calm throughout the year.

Ras Al Jibsh ground was the second most heavily exploited ground by government trawlers during the period under discussion. Twentyseven percent of total effort (772.8 h) was expended on this ground, principally during January through to April (northeast monsoon season). The region south of Ras Al Hadd is strongly affected by the southwest monsoon with the consequence that sea conditions greatly hamper trawling operations by 19.8 m stern trawlers.

The other two grounds were much less extensively exploited; 8 percent (238.7 h) and 4 percent (122.5 h) of total effort was expended on the Suwadi and Sur grounds, respectively. Sur ground was fished primarily by government trawlers while enroute to and from the Ras Al Jibsh ground.

3.2.1.6 Catches and catch rates

(a) Total Catches and Total Catch Rates

Government trawlers, during the 10 month period from December 1976 to June 1978 landed 844 835 kg, with monthly landings ranging from 22 605 to 92 601 kg (Table 3.10). Monthly landings during this period for a single vessel fluctuated from zero to 57 176 kg.

The three government trawlers were operative for a total of 50 vessel/months. Landings per vessel/month ranged from 7 935 to 30 867 kg and averaged 16 897 kg.

The estimated total catches and total catch rates for the different fishing grounds, as determined from the available data on the fishing grounds are given in Table 3.9. Government trawlers averaged 233.2 kg/h total catch for the 19 month period under consideration. There were appreciable differences in catch rates by region and bathymetric interval. Catch rates were approximately 1.7 times higher on the ground south of Ras Al Hadd than on the grounds north of this headland. Total catch rates for Ras Al Jibsh ground averaged 34.0 kg/h, whereas those for the Suwadi, Seeb and Sur grounds averaged 191.3 kg/h, 196.7 kg/h and 196.0 kg/h, respectively. The limited information for the Suwadi and Seeb grounds shows the mean total catch rates for the less than 36 m interval to be 193.0 kg/h and 206.2 kg/h respectively. On the other hand, mean total catch rates for the greater than 36 m interval were 83.7 kg/h for Suwadi ground and 123.9 kg/h on the Seeb grounds.

Figure 3.7 shows the total catch rates realized by month on the principal grounds fished by government trawlers. This information does not show any definite patterns in seasonal availability of demersal fish on the various grounds.

Very few observations were noted on the fishing logs of the quantities of industrial fish discarded; the available observations are summarized in Table 3.11. The availability of industrial fish was very much lower on Seeb ground (48.1 kg/h) than on Ras Al Jibsh ground (182.5 kg/h). Also, the percentage of industrial fish of the total catch was very much lower on the former (15%) than on the latter ground (35%). The bulk of the industrial catch from Ras Al Jibsh ground was comprised of sea catfish (*Arius* sp.). which is little appreciated in Arabian countries.

(b) Catches and Catch Rates by Species Groups

Species composition of 468 589 kg landed by the government trawlers during the July 1977 through June 1978 period for which records were kept was as follows:

	kg	%
Sea Bream (*Argyrops* sp.)	176 404	38
Jacks (Carangidae)	75 656	16
Emperors (*Lethrinus* sp.)	74 216	16
Grunts (*Plectorhynchus* sp.)	48 943	10
Cuttlefish (*Sepia* sp.)	19 533	4
Grouper (*Epinephelus* sp.)	13 110	3
Mixed fish	60 727	13

Table 3.9

DISTRIBUTION OF EFFORT AND ESTIMATED TOTAL CATCH AND TOTAL CATCH RATES ON THE VARIOUS FISHING GROUNDS

Fishing ground		No. drags	Effort (hours)	Estimated total catch (kg)	Total catch rate (kg/h)
Saham		4	7.8	360	46.2
Suwadi	<20 m	102	234.3	45 279	193.3
	20 m>	2	4.3	360	83.7
	<20 m>	104	238.6	45 639	191.3
Seeb	<20 m	660	1 503.4	310 047	206.2
	20 m>	88	195.8	24 269	123.9
	<20 m>	748	1 699.2	334 316	196.7
Sur		49	122.5	24 015	196.0
Jumaila		2	2.3	510	221.7
Ras Al Jibsh		351	772.8	258 095	334.0
Total		1 258	2 843.2	662 935	233.2

Table 3.10

MONTHLY LANDINGS BY GOVERNMENT TRAWLERS FROM DECEMBER 1976 TO AUGUST 1978

Year	Month	Vessel			Total landed	Landing/vessel
		KHASAB	BUKHA	DHALKOT		
1976	December	9 196	13 640	-	22 836	11 418
	Sub-total	9 196	13 640	-	22 836	11 418
1977	January	17 605	19 312	-	36 917	18 459
	February	22 605	-	-	22 605	22 605
	March	21 767	13 039	23 434	58 240	19 413
	April	12 641	15 860	57 176	85 686	28 562
	May	10 964	14 878	11 808	37 650	12 550
	June	-	23 282	18 029	41 311	20 656
	July	8 700	15 434	11 073	35 277	11 759
	August	24 188	6 204	14 081	44 473	14 824
	September	8 515	3 477	11 882	23 874	7 958
	October	29 616	34 321	28 664	92 601	30 867
	November	15 850	-	9 717	25 567	12 784
	December	1 416	21 922	6 717	30 055	10 018
	Sub-total	173 937	167 738	192 581	534 256	16 190
1978	January	18 937	21 444	-	40 381	20 191
	February	26 220	4 338	17 740	48 298	16 099
	March	18 020	24 462	8 920	51 402	17 134
	April	7 758	7 420	8 627	23 805	7 935
	May	26 091	11 074	21 987	59 152	19 717
	June	26 962	13 661	24 082	64 705	21 568
	Sub-total	123 988	82 399	81 356	287 743	16 926
1976-1978	Total	307 121	263 777	273 937	844 835	16 897
No. months landed		18	17	15	50	
Landing/month		17 062	14 654	18 262	16 897	

Table 3.11

CATCH RATES AND PERCENTAGE OF MARKETABLE AND INDUSTRIAL FISH TAKEN BY GOVERNMENT TRAWLERS ON TWO FISHING GROUNDS

Fishing ground	Period	Number of drags	Duration (h)	Marketable fish		Industrial fish		Total kg/h
				kg/h	%	kg/h	%	
Seeb	May 1977	11	17.1	319.3	95	17.5	5	336.8
	June 1978	8	25.3	241.9	78	68.8	22	310.7
	Total	19	42.4	273.1	85	48.1	15	321.2
Ras Al Jibsh	March 1977	22	68.1	428.2	80	110.1	20	538.3
	March 1978	27	55.0	282.0	50	285.8	50	567.8
	May 1978	26	59.6	300.7	64	169.9	36	470.6
	Total	75	182.7	342.6	65	182.5	35	525.1

Species composition of catches differed markedly on the various fishing grounds. Catches on the northernmost grounds were comprised of several species groups, whereas catches on the southernmost ground were dominated by a single species.

Suwadi Ground (Table 3.12) - The highest mean catch rates of 59.7 kg/h of emperors and 55.3 kg/h of grunts were taken on this ground. Mean catch rates of jacks and cuttlefish were relatively high at 18.9 kg/h and 13.2 kg/h respectively. Monthly catch rates were highest for these fish groups in July and for cuttlefish in December.

Seeb Ground (Table 3.13) - Dominant species were emperors, jacks and grunts, with mean catch rates of 47.3 kg/h, 46.8 kg/h and 34.6 kg/h, respectively. Mean catch rates on this ground of jacks, cuttlefish (15.0 kg/h) and groupers (9.9 kg/h) were highest of all grounds. Monthly catch rates of jacks were highest from September through November and of cuttlefish from October through May.

Sur Ground (Table 3.14) - Catch rates of the dominant groups averaged 92.4 kg/h for sea bream, 48.1 kg/h for emperors and 24.2 kg/h for jacks. Grunts and groupers were only captured during January and May. Cuttlefish were absent from this ground.

Ras Al Jibsh Ground (Table 3.15) - Sea bream accounted for 80 percent of the catches from this ground, with mean catch rates of 264.9 kg/h. This catch rate exceeded the combined catch rates of all species groups on the other grounds. The only other species group captured in any quantities was jacks, the catch rates of which averaged 29.2 kg/h. Emperors and especially grunts and cuttlefish, were rarely taken on the Ras Al Jibsh ground.

Table 3.12

CATCH RATES (kg/h) BY MONTH AND SPECIES GROUPS ON THE SUWADI GROUND

Month	Effort (h)	Lethrinus	Carangidae	Plectorhynchus	Argyrops	Epinephelus	Sepia	Mix	Total
July 1977	20.1	101.6	37.8	73.6	2.2	9.0	13.9	16.9	255.0
Aug. 1977	19.9	55.2	20.4	65.3	2.0	14.1	5.0	6.6	168.6
Dec. 1977	70.0	66.3	24.3	66.0	5.7	8.1	21.1	28.3	219.8
Mar. 1978	13.0	64.6	12.3	27.7	6.2	10.9	9.2	3.1	134.0
April 1978	6.5	21.5	3.1	21.5	6.2	5.8	6.2	15.4	79.7
May 1978	64.8	43.8	9.6	43.8	4.6	4.4	8.3	8.0	122.5
Total	194.3	59.7	18.9	55.3	4.6	7.7	13.2	16.0	175.4
Percent	-	34	11	32	3	4	7	9	100

Table 3.13

CATCH RATES (kg/h) BY MONTH AND SPECIES GROUPS ON THE SEEB GROUND

Month	Effort (h)	Lethrinus	Carangidae	Plectorhynchus	Argyrops	Epinephelus	Sepia	Mix	Total
July 1977	212.8	43.0	33.4	28.1	5.5	5.0	5.0	29.2	149.0
Aug. 1977	212.1	53.9	34.1	50.0	11.4	10.9	5.0	20.1	185.4
Sept. 1977	128.3	32.6	78.6	22.9	8.5	9.5	4.0	25.3	181.4
Oct. 1977	284.8	58.5	65.3	34.5	9.1	13.1	29.7	38.1	248.3
Nov. 1977	60.3	17.9	50.3	13.4	10.6	6.7	20.1	42.1	161.1
Dec. 1977	32.5	49.8	2.5	56.0	0.6	6.5	28.9	60.3	204.6
Jan. 1978	39.7	24.9	17.6	35.3	2.5	10.1	18.6	19.1	128.1
Apr. 1978	36.5	70.7	25.8	34.5	0.5	19.4	31.2	40.5	222.6
May 1978	15.5	46.4	7.7	43.0	2.6	6.4	15.5	12.9	135.4
Total	1022.5	47.3	46.8	34.6	7.9	9.9	15.0	30.8	192.4
Percent	-	25	24	18	4	5	8	16	100

Table 3.14

CATCH RATES (kg/h) BY MONTH AND SPECIES GROUPS ON THE SUR GROUND

Month	Effort (h)	Lethrinus	Carangidae	Plectorhynchus	Argyrops	Epinepherus	Sepia	Mix	Total
Sept. 1977	8.8	2.3	95.4	0.0	109.1	0.0	0.0	8.8	215.6
Nov. 1977	7.0	5.7	11.4	0.0	117.1	0.0	0.0	22.9	157.1
Jan. 1978	13.3	36.1	27.1	3.0	154.9	5.4	0.0	25.5	252.0
Feb. 1978	2.3	0.0	0.0	0.0	60.9	0.0	0.0	8.7	69.6
Apr. 1978	8.0	2.5	5.0	0.0	67.5	0.0	0.0	7.5	82.5
May 1978	61.3	69.8	18.3	8.2	78.0	5.9	0.0	35.2	254.2
Total	100.6	48.1	24.2	5.4	92.4	4.3	0.0	28.6	226.1
Percent	-	21	11	2	41	12	0	13	100

Table 3.15

CATCH RATES (kg/h) BY MONTH AND SPECIES GROUPS ON THE RAS AL JIBSH GROUND

Month	Effort (h)	Lethrinus	Carangidae	Plectorhynchus	Argyrops	Epinephelus	Sepia	Mix	Total
Sept. 1977	6.0	0.0	13.3	0.0	13.0	0.0	0.0	0.0	20.6
Oct. 1977	18.0	0.0	62.0	0.0	666.7	0.0	4.4	23.3	756.6
Nov. 1977	35.7	5.0	37.5	1.1	279.6	0.0	0.0	89.5	412.7
Jan. 1978	89.0	6.5	44.0	0.7	267.9	0.0	0.0	39.8	358.9
Feb. 1978	135.3	3.4	29.7	0.0	252.8	0.1	0.0	24.4	310.4
Mar. 1978	165.1	0.0	22.8	0.0	248.3	0.0	0.0	46.5	317.6
Apr. 1978	66.5	1.8	12.6	0.0	214.7	0.0	0.0	9.0	238.1
May 1978	59.6	0.0	28.5	0.0	284.9	0.0	0.0	9.4	321.8
Total	575.2	2.3	29.2	0.2	264.9	0.0	0.1	33.4	330.1
Percent	-	1	9	0	80	0	0	10	100

Table 3.16

ESTIMATES OF DEMERSAL FISH DENSITIES DERIVED FROM OPERATIONS WITH FISH TRAWLS IN VARIOUS AREAS OF THE GULF, GULF OF OMAN AND NORTH ARABIAN SEA

Area	Vessel	Towing speed (knots)	Density (kg/h)		
			Market fish	Industrial fish	Total
Gulf					
Iranian coast	TATSUTA MARU	3.5[1]	41.8	?	?
Arabian coast, Qatar Peninsula, United Arab Emirates	GAZELLE	3.5	17.3	19.5	36.8
Gulf of Oman	Government trawlers	2.7	26.4	4.0	30.4
Northeast coast of Oman					
North Arabian Sea					
Southeast coast of Oman	Government trawlers	2.7	45.2	15.8	61.0
Southeast coast of Oman[2]	Taiyo trawlers	3.5	63.0	?	?

---

[1] Estimated towing speed

[2] Yesaki, 1978

3.3 COMPARISON OF AREAS IN THE GULF AND GULF OF OMAN

Seasonal patterns of relative bottomfish availability differed from one area to another in the Gulf. Catch rates of marketable fish by the TATSUTA MARU, fishing off the Iranian coast during the hot season, were almost two times that of the cool season Similarly, the EL HADITH obtained total catch rates in Kuwait territorial waters during the hot season which were almost double that obtained in this area by the UMITAKA MARU during the cool season. The EL HADITH and UMITAKA MARU used 18.0 m and 22.0 m headrope length shrimp trawls. On the other hand, the GAZELLE, fishing on the Arabian side, obtained total catch rates which were not significantly different between these seasons and marketable fish catch rates which were slightly lower in the hot than in the cool season. There was no apparent fluctuation in seasonal availability of demersal fish in the Gulf of Oman and the northern Arabian Sea.

Catch rates were converted to densities to facilitate comparisons of relative bottomfish abundance in the various areas of the Gulf. This was accomplished by dividing the catch per hour rates by the area swept during a one hour drag. The area swept was estimated by assuming the working spread of a trawl to be 50 percent of headrope length (or 40 percent of footrope length) times the average towing speed. It was further assumed that herding effect of the otter boards-sweepline-bridle assemblage was equal to escapement out of the trawl's path, that is, all fish within the working spread were captured by the trawl. Table 3.16 gives the estimates derived from the catches with shrimp and fish trawls.

The results of commercial fish trawling operations show densities of marketable fish to be highest in the north Arabian Sea (45.2-63.0 kg/h). The Iranian side of the Gulf supports the next highest density of marketable fish (41.8 kg/h), followed by the Oman side of the Gulf of Oman (26.4 kg/h). Lowest density of 17.3 kg/h of marketable fish occurred on the Arabian side of the Gulf. However, a high proportion of industrial fish in this area elevates the total catches. The index of demersal fish density for the Gulf of Oman and the north Arabian Sea reflects scanty records and large sized meshes used for codends. Total demersal fish density on the Oman side of the Gulf of Oman is probably similar to that of the Arabian side of the Gulf but, in the latter area, there is a higher percentage of industrial fish.

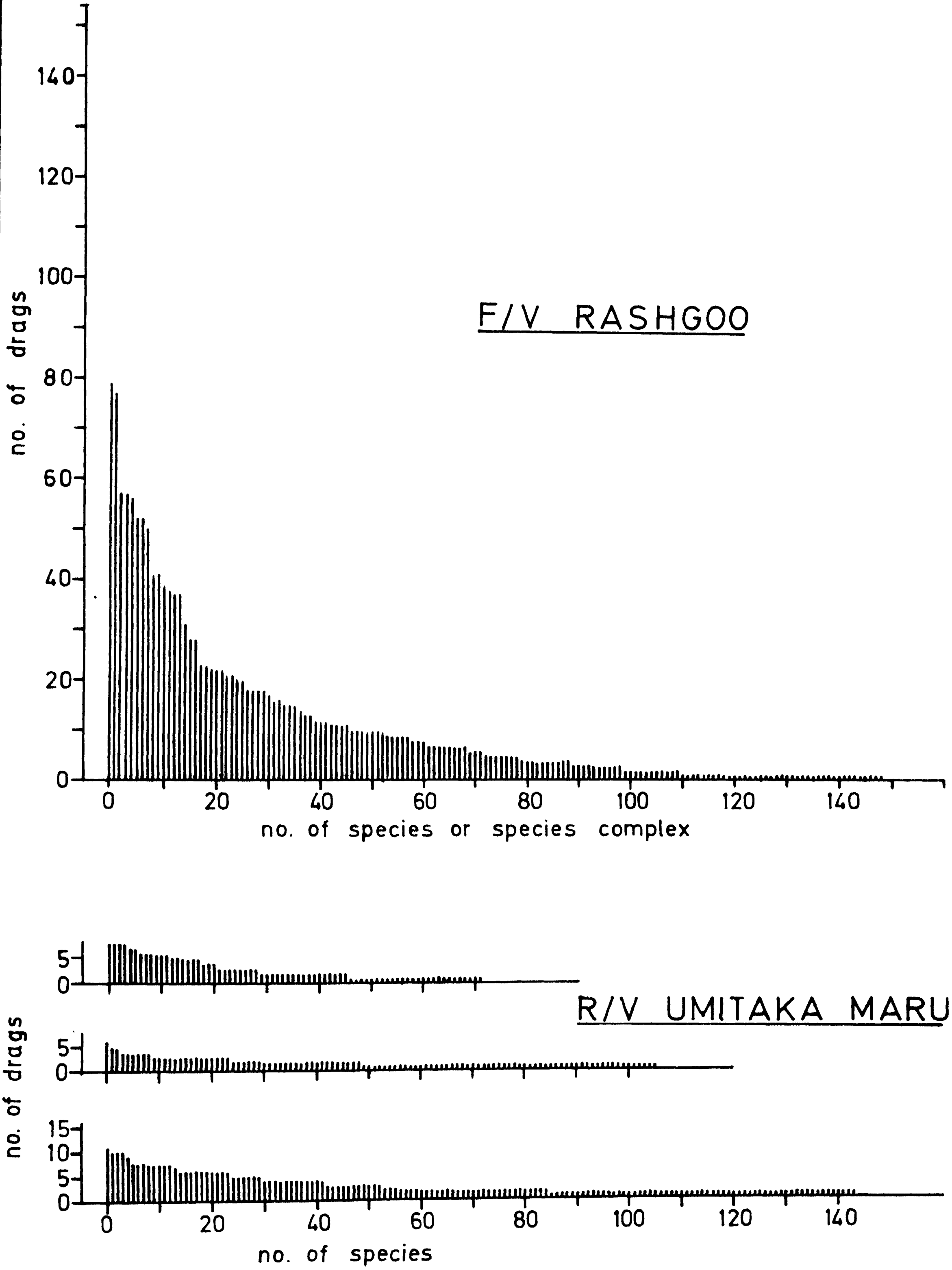


Fig. 3.1 Frequency of capture of species by F/V RASHGOO and R/V UMITAKA MARU

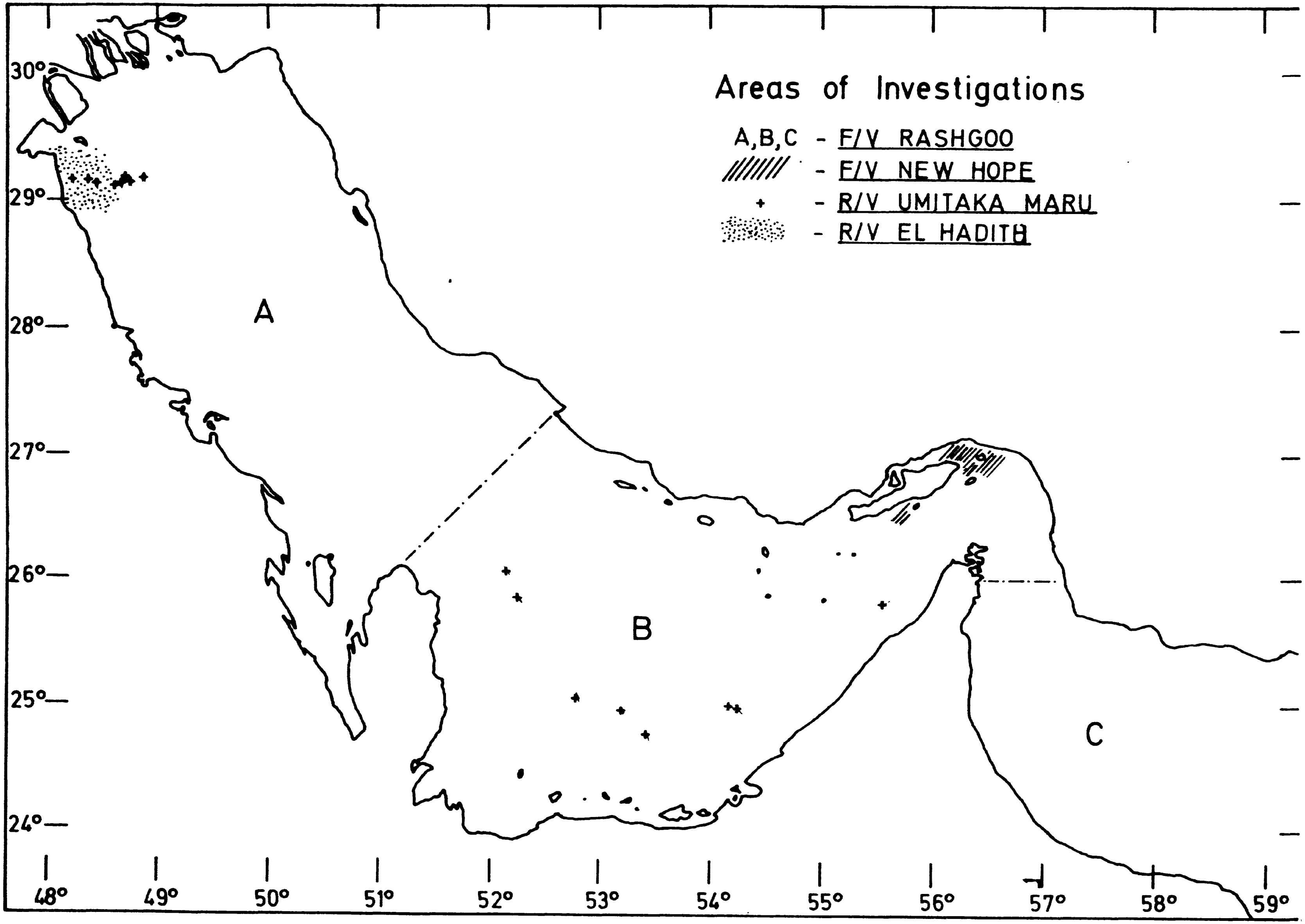


Fig. 3.2 Areas investigated by F/V RASHGOO, F/V NEW HOPE, R/V UMITAKA MARU and R/V EL HADITH. (A - Northwestern Gulf, B - Southeastern Gulf and C - Gulf of Oman)

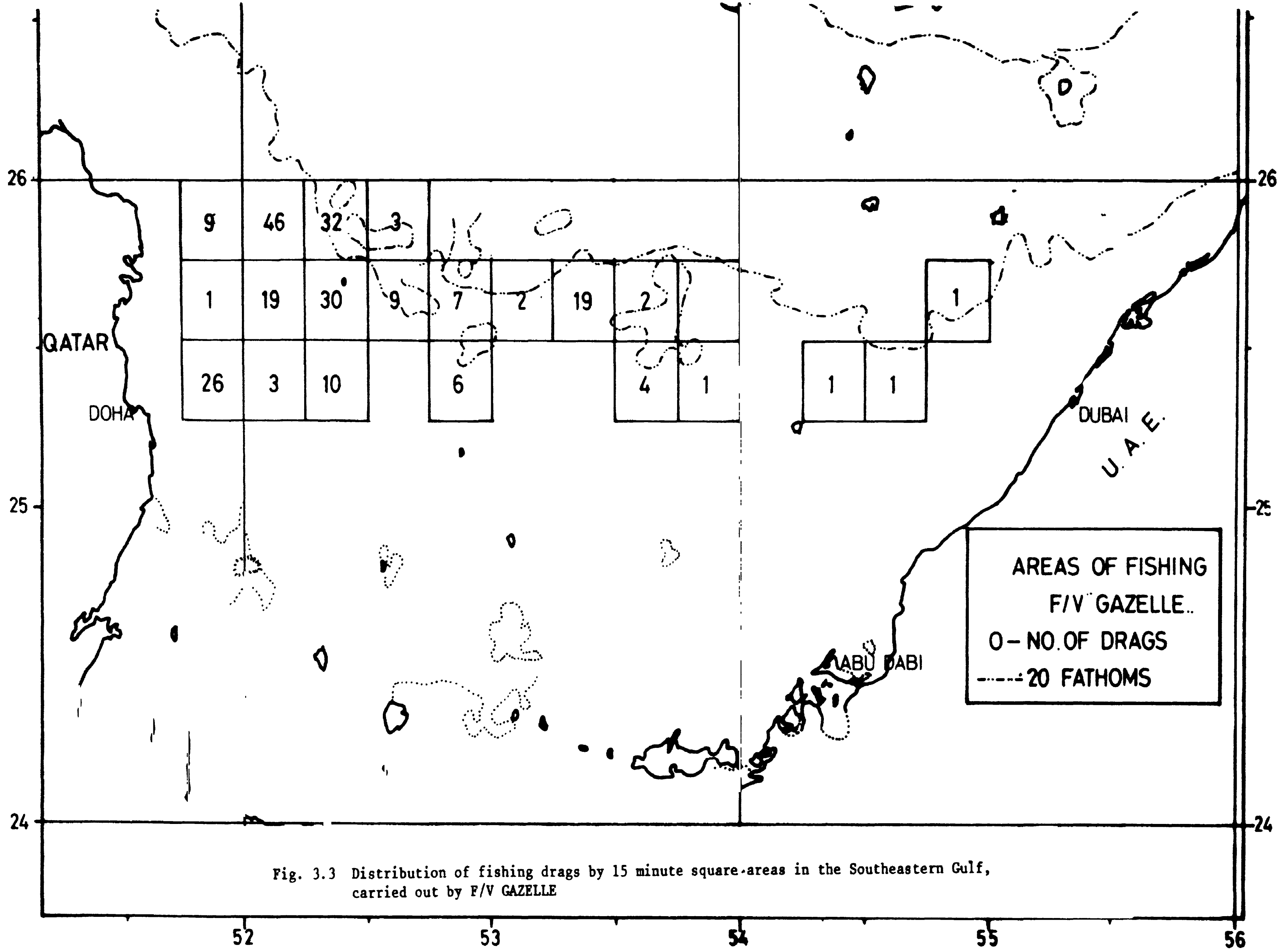


Fig. 3.3 Distribution of fishing drags by 15 minute square-areas in the Southeastern Gulf, carried out by F/V GAZELLE

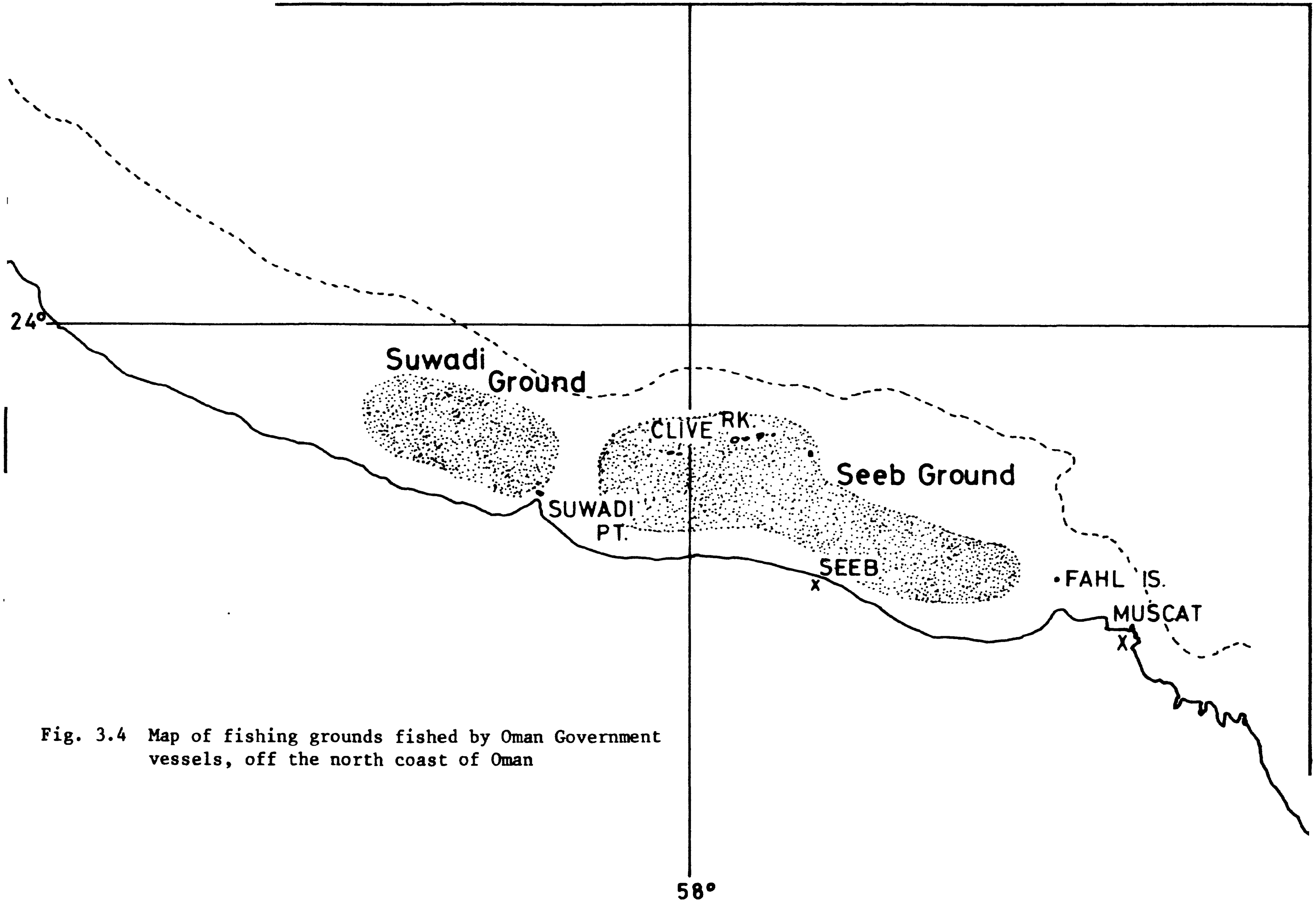


Fig. 3.4 Map of fishing grounds fished by Oman Government vessels, off the north coast of Oman

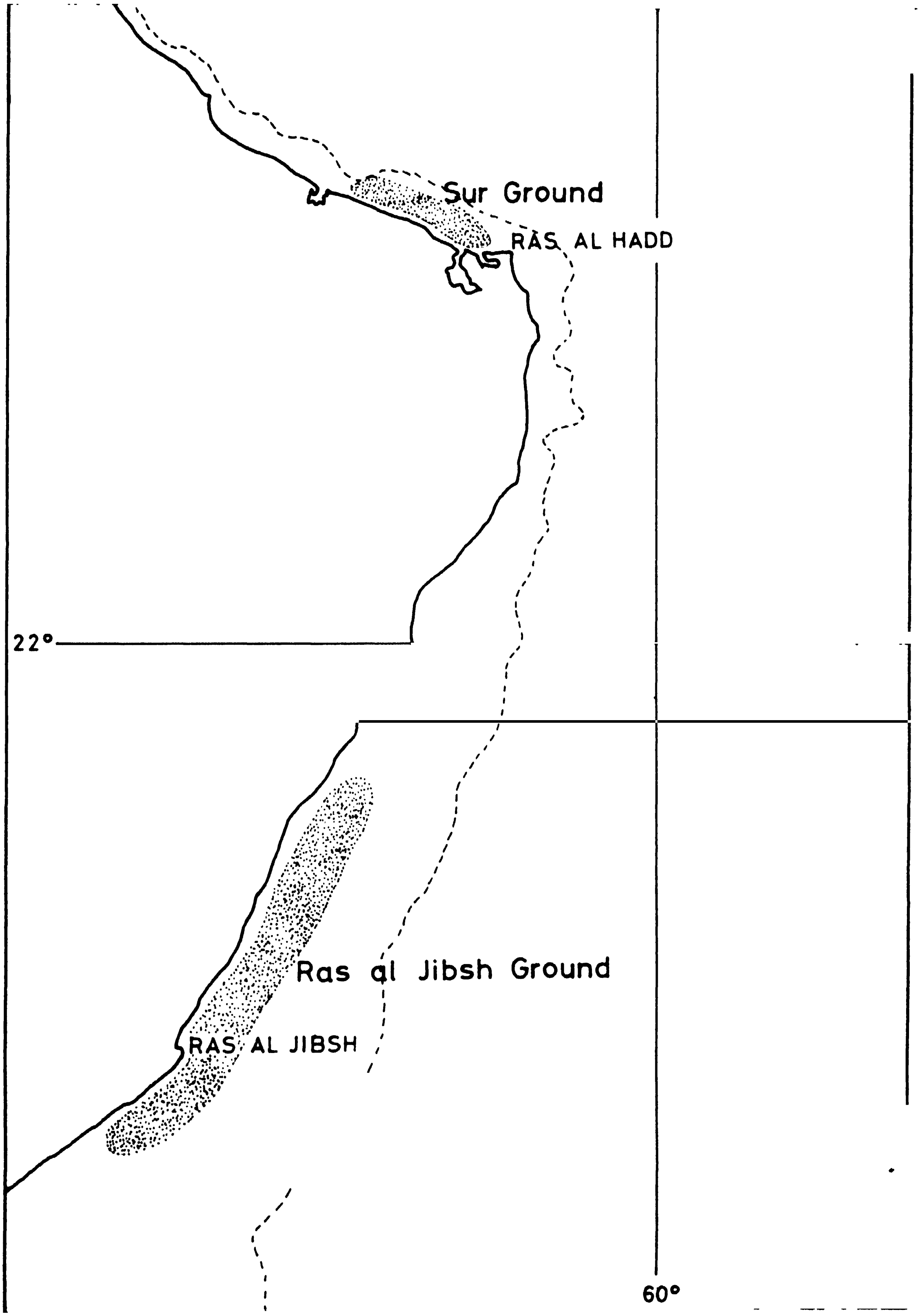


Fig. 3.5 Map of fishing grounds fished by Oman Government vessels off the central coast of Oman

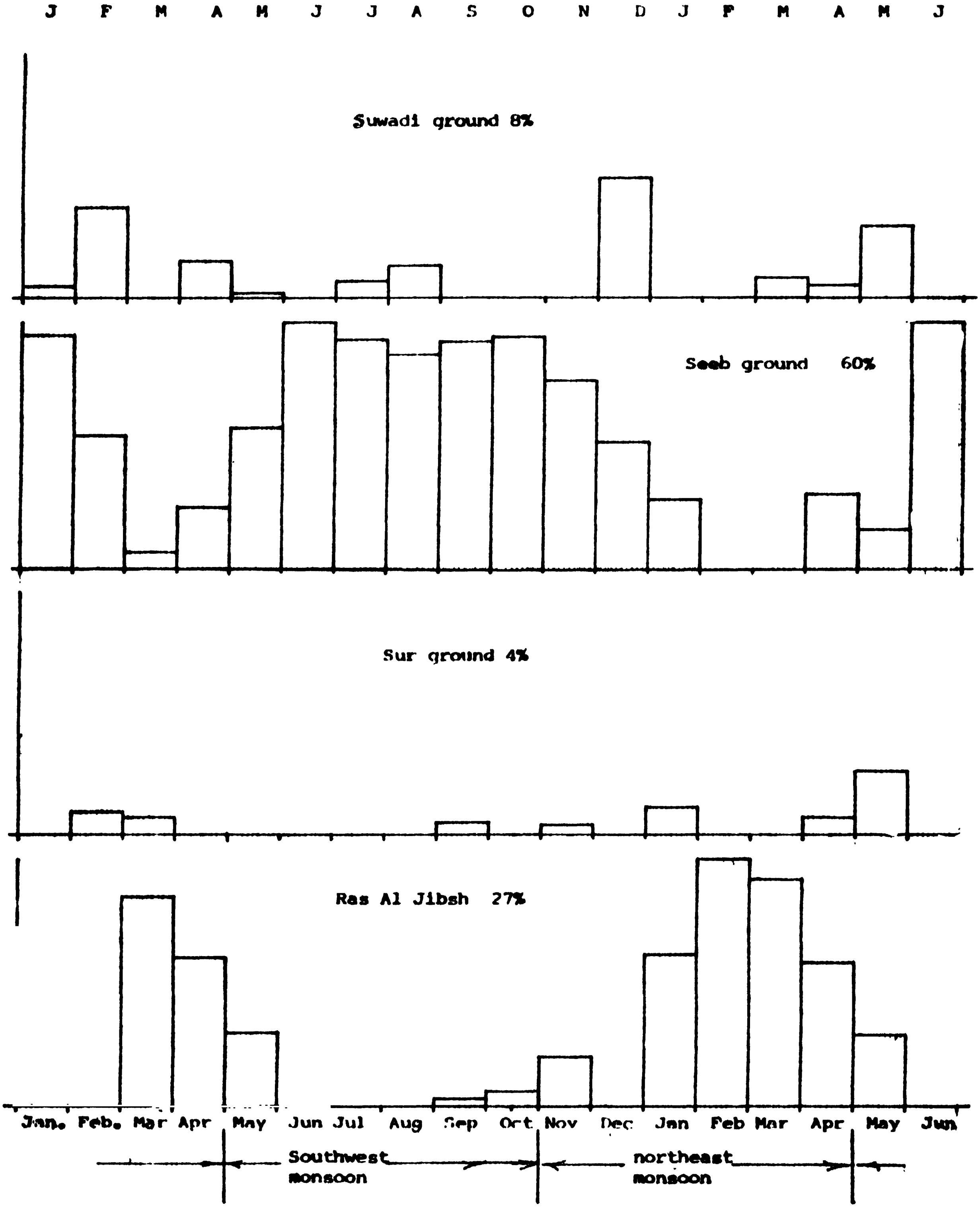


Fig. 3.6 Percentage distribution of fishing effort (hours) on the principal grounds fished by Government trawlers

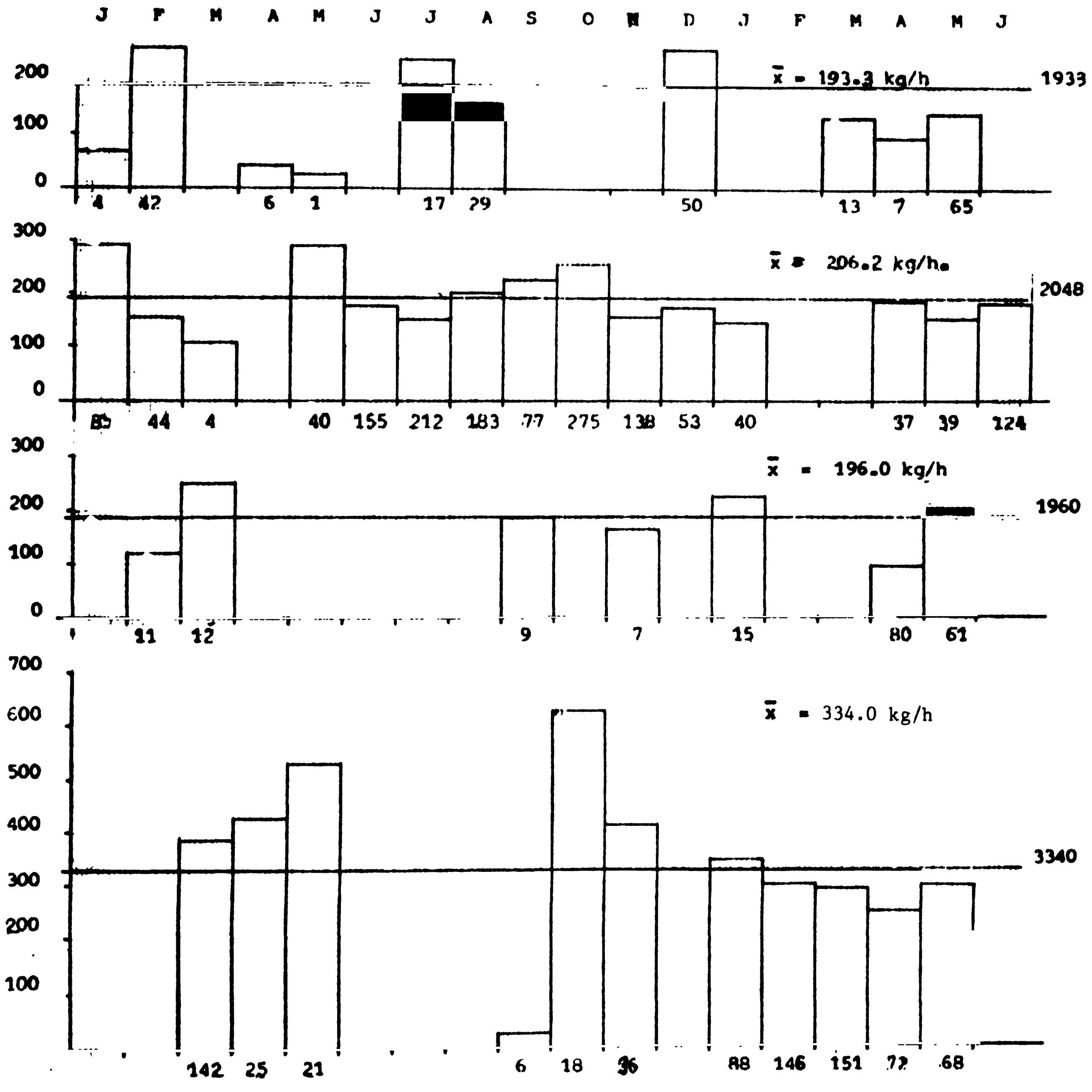


Fig. 3.7 Total monthly catch rate (kg/h) obtained in the principal fishing grounds

Part 4

DISCUSSION AND EVALUATION OF THE DEMERSAL RESOURCES

by

K. Sivasubramaniam

4.1 PRODUCTION ESTIMATES OF DEMERSAL SPECIES

Evaluation of the fish production in the survey area was attempted in order to determine the present state of exploitation of the stocks, information required to estimate the potential yields from the biomass estimates obtained for the survey area and also to gather more information on the catch composition, catch rates and seasonal variation.

Existing fisheries may be basically classified as the artisanal fishery for finfish and shrimps and the large-scale fishery for finfish and shrimps. Reasonably good information on the production of the large-scale fishery for shrimp and finfish are available in most of the project countries but this is not so in the case of the artisanal fisheries. In the absence of reliable information on artisanal fisheries, estimations have been based on sampling conducted by project biologists stationed in six out of the eight project countries and this was supplemented by consulting reliable sources in various member countries and referring to literature. It is stressed that these estimates are very rough and subject to correction.

In Table 4.1 the estimated production is given of pelagic and demersal fish and shrimp by country. In Table 4.2 a subdivision is made between artisanal and large-scale fisheries, irrespective of the group of fish.

Over 70 percent of the total fish production in the project area is contributed by the artisanal fishery. The large-scale fishery is directed more towards the production of shrimps than finfish (Table 4.2). A large-scale fishing fleet in Iraq apparently operates mainly outside the project area.

The status of the shrimp stocks in the survey area was assessed by an *ad hoc* group in 1976 (FAO, 1977a), and the expected effects of regulatory measures were also reported to the Coordinating Sub-Committee of the Regional Fishery Survey and Development Project in 1977 (FAO, 1977b). Further studies on this subject were actively pursued by the Shrimp Resources Evaluation and Management Project in Kuwait, and by the Saudi Arabian Fisheries Development Project. The shrimp fishery takes place exclusively within the Gulf.

The total average production of shrimp was estimated to be 9 600 t over 1976-78. A large amount of demersal fish is caught as a by-catch of the shrimp fishery. For calculation of potential yield, it is assumed that 10 000 t of commercially valuable species have been caught and discarded by this fishery.

The total catch of commercially valuable demersal fish (excluding shrimp) is then estimated to be 57 850 t, of which 47 850 t are landed. From the Gulf of Oman 23 000 t are landed and from the Gulf 24 850 t (say 25 000 t). The discards of 10 000 t are considered to have been made in the Gulf.

4.2 FISHING AREAS AND GEAR

The large-scale fishery for demersals seems to be concentrated in the 'B' stratum of the Gulf and the Gulf of Oman, as is the case of the artisanal fishery. This identification of fishing areas, gained through years of trial and error, is in conformity with the results of the present survey. Further, the catch compositions in the existing demersal fisheries are similar to those identified by the survey. It is reasonable to consider that the present yield from existing fisheries is a component of the major demersal stocks identified by the survey and, therefore, the estimate of the potential yield should take into account the estimated degree of present exploitation. The fact that some of the existing classes of artisanal craft are able to reach out to areas of major fish concentrations is a very significant point to be considered in planning future expansion and development of the fishing industry (Hartsuijker et al., 1981).

Table 4.1

ROUGH ESTIMATES OF THE GENERAL ANNUAL PRODUCTION
LEVEL (1976-1978) OF VARIOUS MAJOR KINDS OF FISH
AND SHRIMPS IN THE PROJECT AREA (t)

Country	Large pelagic	Small pelagics	Demersals	Shrimp	Total
Iran	6 000	3 000	24 000	2 000	35 000
Iraq	100	100	800	?	1 000
Kuwait	500	650	3 600	2 800	7 550
Saudi Arabia	1 000	150	3 850	1 600	6 600
Bahrain	700	50	2 050	2 200	5 000
Qatar	500	100	1 000	1 000	2 600
UAE	3 200	250[1/]	6 050[2/]	0	9 500
Oman	9 000	5 000	6 500	0	20 500
Total	21 000	9 300	47 850	9 600	87 750
Percentage	23.9	10.6	54.5	10.9	100

1/ Does not include the 5 000 t of sardines caught by Ras Al Khaimah Company in 1977

2/ Includes the 1 500 t caught by Japanese joint venture in Fujaira

The shrimp grounds are mainly in the very shallow stratum 'A', where either the mean density values for fish are low, as on the Arabian side, or there is a very high concentration of noncommercial fish species such as ponyfish, as on the Iranian side. Further sampling in the latter area revealed frequent occurrence of ponyfish, therapons, catfish, sardines, flatfishes and skates, while the quantities of more valuable lizardfish, threadfin bream, trevally and scad were relatively very small. However, insofar as the shrimp fishery also destroys young fish of marketable species, its effect on the biomass of these species may be important.

Practically all marketable species groups identified during the survey also enter the artisanal fishery. In the artisanal fishery, the popular traditional fishing gear is the trap (gargoor), besides which trawls, gillnets, trolling lines, handlines, stakenets, castnets and, in some specific areas, beach seines are used. These methods are applied generally in waters less than 50 m in depth. The trawls, gillnets, stakenets, castnets and beach seines are used predominantly in the shallow stratum 'A', while traps, handlines and trolling lines are more often used in the 'A' and 'B' strata, more particular in the latter depth zone. Very little effort is distributed in the 'C' stratum, at least within the Gulf. In the Gulf of Oman, where the shelf is very narrow, there is no clear-cut depthwise distribution of effort and trawling by artisanal craft is not common.

Table 4.2

ROUGH ESTIMATE OF THE GENERAL ANNUAL PRODUCTION LEVELS (1976-1978) OF THE ARTISANAL AND LARGE-SCALE FISHERIES IN THE PROJECT AREA (t)

Country	Artisanal		Large-scale		Total
	Shrimp	Fish	Shrimp	Fish	
Iran	800	20 000	1 200	13 000[1]	35 000
Iraq	?	1 000	?	?	1 000
Kuwait	500	4 400	2 300	350[2]	7 550
Saudi Arabia	1 500	5 000	100	0	6 600
Bahrain	200	2 000	2 000	800	5 000
Qatar	100 (?)	1 300	900	300	2 600
UAE	0	8 000	0	1 500	9 500
Oman	0	20 000	0	500	20 500
Total	3 100	61 700	6 500	16 450	87 750
Percentage	3.5	70.3	7.4	18.7	
	73.8		26.2		100

[1] 10 000 of demersals plus 3 000 large pelagics

[2] Estimated for January-April 1979 only

With Iran bordering the entire length of the coastline on the northern side of the survey area, its production of demersals roughly equals that of all the Arabian countries bordering the corresponding southern coastline. Data on the estimated catches by country are given in Table 4.1. About 48 000 t of demersal fish are landed annually from the survey area by all countries together, which is approximately 54 percent of the total production of fish from the Gulfs.

In Oman, the average daily landing of demersal species per fishing craft is estimated at 55 kg and in the UAE a large dhow (45-50 ft class) could produce as much as 4 000 kg after a five-day trip to lift about 250 pots or traps (gargoor). In Saudi Arabia the artisanal shrimp trawlers showed an average catch per boat of about 90 kg of shrimps per day (Hull, 1978) and other artisanal fishing methods produced between 80 and 300 kg of fish/boat/landing. In Qatar, the average landing by an artisanal craft has been stated as 25 kg/boat in the answers to a questionnaire sent out by the project.

The large-scale fishery for demersal fish exists to varying extent in almost all the member countries in the survey area except Saudi Arabia and this demersal fishery contributes nearly 18 percent to the total production. The largest contributor in this sector is Iran (Table 4.2) which has a fleet of Korean vessels operating along its coast. About 3 000 t of their catch consists of large pelagics. The species landed include almost all the marketable groups identified during the survey. The unmarketable fishes are discarded at sea. Kuwait trawlers are presently operating in the northwestern part of the Gulf (Area 1), Bahrain vessels in the waters around Bahrain and noticeably in the area between Qatar and

UAE and Qatar's single vessel operates entirely east of Qatar. All these vessels are concentrating their efforts mainly in the 20-40 m depth range. Two trawlers were operating off Fujaira, on the east coast of UAE, during 1977/78. The Oman Government owns three vessels which have been operating off its northern and northeastern coasts since 1976.

4.3 CATCH RATES

Large-scale (industrial) shrimp trawling is conducted by Iran, Kuwait, Saudi Arabia, Bahrain and Qatar. The production rate is estimated to be in the region of 150 t/boat/season in Qatar, 50 t/boat/season in Saudi Arabia (Hull, 1978), 153 t/boat/season in Bahrain, 55 t/boat/season in Kuwait and 57 t/boat/season in Iran.

The results of the large-scale trawling indicated an annual production with little seasonal variation. The highest annual rate of marketable fish per vessel was observed in the UAE trawling operations with 800 t/boat/annum and Oman vessels about 166 t/boat/annum (see Part 3). The Bahrain vessels achieved 200 t/boat/annum and results from Kuwait vessels, which commenced operations late in 1978, indicated a possible production rate of 350 t/boat/annum. If the available figures for Iran are acceptable, then the highest production rate in the region of 1 000 t/boat/annum would be realized. Annual production rates have been considered because of insufficient information for determining catch per hour of trawling, which is available only in some cases. These cases are as follows:

Oman vessels - 190 kg/h (see Part 3)

Qatar vessels - 405 kg/h (see Part 3)

Kuwait vessels - 380 kg/h (Hartsuijker)

The USSR vessel RTM LESNOI (2 435 GRT) carried out demersal fish trawling together with a fleet of seven shrimp trawlers of 929 GRT (SRTM) between 1965 and 1968. The shrimp trawlers showed a catch composition of 23.1% shrimp, 10% marketable fish and 66.2% industrial fish. The LESNOI operations resulted in catch rates of 550 kg/h of marketable fish and 1 075 kg/h of industrial fish in the northwestern Gulf (west of 52°E) and 408 kg/h of marketable and 1 826 kg/h of industrial fish in the southeastern part of the Gulf (between 52° and 55°E). PPR VAN GOGH operating off Bushehr and Ras Al Mutaf in the northwestern Gulf between December 1966 and March 1967 averaged 3.0-3.5 t/day of marketable fish and as much as 16 t/tow of ponyfish, moonfish and 5 t/tow of ribbonfish. From the results of these investigations the USSR concluded that a daily catch rate of 5 t of marketable fish and an unspecified quantity of industrial fish for fishmeal could not be obtained in the Gulf. These catch rates were not economically attractive for heavy displacement trawlers and, except for shrimps, the Gulf was of no great interest to the Soviet fishing fleet (see Part 3).

The purse seiners of the Ras Al Khaimah Fishing Company were converted into trawlers for experimental trawling with Calypso and Campelen trawls in the shallow waters (10-35 m) between Shams and Umm al Quaiwain on the west coast of the United Arab Emirates. The results of this experiment are not very clear, since 58 hauls out of 156 were reported to be without catch, which is very unusual in a trawl fishery. It is possible that this refers to catch of marketable fish only, in which case the catch per hour trawling was 84 kg in February, 77 in March, 21 in October, 113 in November and 120 in December. Catch rates based on total estimated catch and total effort were much higher, respectively 358, 274, 80, 417 and 351 kg per hour. An average 27 percent of the fish was marketable. It should be noted that trash fish and unmarketable fish discarded at sea are very rarely recorded by commercial fishing vessels (Scheffers, 1979).

Results of other exploratory fishing for demersals revealed the following catch rates (see Part 3).

NEW HOPE (off Iran coast of Area 1) - 40 kg of shrimp and fish/hour

TATSUTA MARU (off Iran coast of Area 1) - 1 053 kg of fish/hour

UMITAKA MARU (off Kuwait) - 49.7 kg of fish/hour

UMITAKA MARU (southeastern Gulf) - 93.1 kg of fish/hour

The evidence from exploratory fishing vessels indicates that about 40 to 50 percent of the catch is classified as trash and unmarketable fish (see Part 3).

4.4 ESTIMATES OF POTENTIAL YIELD

The potential yield of a fish stock depends on the stock abundance and the biological characteristics of the species. For instance, the percentage of the stock which can be harvested annually without depleting the stocks too much and thereby reducing its productivity in the succeeding years is much lower for long-living fish than for short-living species. Little is known of the life span and thus of the natural mortality rate of the species in the area. It can be expected that there is a considerable difference in the natural mortality rates between different species. In general, however, several species in tropical waters appear to have a moderate life span of, say, between about three and eight years. Species like *Epinephelus tauvina* (grouper) may live up to about 16 years (Hull, personal communication), while *Leiognathus* species may have a life span of about 2-3 years.

At or around the maximum sustainable yield, the rate of natural mortality (M) and the rate of fishing mortality (F) are roughly equal and the catch rate will be roughly half the catch rate obtained from an unexploited (virgin) stock.

A first approximation to determine maximum potential yield for an unfished resource is given by the formula $Y_{max} = 0.5 \, M \, B_o$, where M is the natural mortality rate, and B_o the virgin stock.

If the fishery is already taking an annual catch of C tons per year, and the mean annual biomass is $\bar{B}$, then the formula is modified to

$$Y_{max} = 0.5 \, (C + M\bar{B})$$

The natural mortality rate, expressed as an instantaneous rate M, may range from around 2 for small short-lived species to 0.2 for long-lived species like groupers.

The natural mortality (M) of the fish species in the Gulfs are not well known, and it has been assumed that, on the average for the mixture of commercial species found, an M of 0.5 would be reasonable.

Application of the above formula to all demersal fish species, excluding shrimp, but including a total discard of 20 000 tons, the following potential yields are obtained, based on the rather low rate of natural mortality M = 0.5 and the results presented in Table 1.10.

Y_{max} all demersal species, excluding shrimp

Gulf of Oman: $0.5 \; (23\,000 + 0.5 \times 166\,000) = 53\,500$ t

Gulf : $0.5 \; (45\,000 + 0.5 \times (1\,060\,000 - 166\,000)) = 246\,000$ t

Both Gulfs : $53\,500 + 246\,000 = 299\,500$, say 300 000 t

According to Table 1.10 (Part 1) the standing biomass of commercially valuable demersal species in the Gulfs is 602 813 t, of which roughly 100 000 t is found in the Gulf of Oman (Area 3), and 500 000 t in the Gulf (Areas 1 and 2). The catches of this category of fish in the areas are respectively 23 000 and 35 000 t (including 10 000 t discarded, but killed fish). Applying these figures in the second formula with M = 0.5 the following figures are obtained for potential yield of commercially valuable fish:

Gulf of Oman $Y_{max} = 0.5\ (23\ 000 + 0.5 \times 100\ 000) = 36\ 500$ t

Gulf $Y_{max} = 0.5\ (35\ 000 + 0.5 \times 500\ 000) = 142\ 500$ t

Total $Y_{max} = 36\ 500 + 142\ 500 = 179\ 000$ t

4.5 GENERAL EVALUATION

In considering the results of the survey, a number of aspects should be taken into account. The total potential yield given in this report is the estimated yield if all species and populations of species are exploited at their optimum level. Because different species require different levels of fishing to give the optimum production and, on the other hand, the fishery catches many species at the same time, it will be possible to exploit each species at its optimum level. Therefore,the optimum production which can be obtained in practice will be less than the total potential of all species together, perhaps about 80 percent of the estimated total potential. Little is known so far about the question of the migrations and the division into separate, independent populations of the same species throughout the area. It is unlikely that by fishing mainly within one part of the area, one could harvest the production potential of all the populations throughout the whole area. Therefore, the figure of 80 percent of the estimated total potential yield can only serve as a guideline for a fishery which is spread fairly evenly throughout the Gulf. It can be expected that by concentration of a fishery in the most productive areas, the total production which will be obtained will again be less than the above figure.

Further, it should be noted that the catch rates presented in this report are the average catch rates, obtained mainly with the survey standard trawl, of a number of trawl stations selected at random within each substratum. It may be expected that commercial vessels will not only concentrate in those substrata which will provide the best catches of the desired species composition but will also concentrate at the best fishing grounds within each substratum. To that extent, the commercial catch rates of the desired species within each substratum can be expected to be higher than those obtained during the survey for vessels of the same fishing power and using the same gear. Some idea of possible commercial catch rates is given by the results of the indicative fishing experiments and information can also be found in the review of fishing results in the area reported in Part 3. (In considering the information in this Part it should be taken into account that the catch rate data refer to different vessels with different fishing power and type of trawls.)

Although the present commercial catch rates will be higher than those given in this report, it should also be taken into consideration that when fishing increases, the amount and the density of the fish in the sea decreases, which will result in a decrease in the average catch rates. This decrease will again be different for different species but, as a very rough guide, it may be assumed that the catch rate of a vessel of the same fishing power and using the same gear as at present in a fishery which exploits the stock at its optimum level, may lie between one half and three quarters of the present commercial catch level (taking into account that the present fish stocks are already to some extent exploited). However, a commercial fishing vessel of the same fishing power and using the same gear as the survey vessels will, on the average, obtain a higher catch rate in each substratum than those obtained during the survey. Therefore, at the level of fishing giving the optimum total production, the commercial catch rates of such vessels are perhaps not less than three-quarters of the catch rates obtained during the survey.

Further, the catch rates realized during the survey and indicative fishing are related to the size range of the vessels and the size of the trawl gear used, and similar catch rates will not be achieved by smaller vessels operating a smaller size of trawl.

The biomass estimates and those of potential yield given in this report refer to the demersal stocks only. In addition, it has been shown that the trawl catches substantial quantities of pelagic species, which is important for the commercial viability of a demersal fishery. The potential yield of these pelagic species cannot be estimated from the demersal survey because part of these stocks will be in water levels higher than those sampled by the trawl. A better estimate of the pelagic stocks will arise from the pelagic survey and the data on these stocks from the demersal survey will give an underestimate. How much of the potential yield of the pelagic stocks can be harvested by the demersal fishery, and thereby add to the potential which can be obtained from the demersal stocks, will depend to a large extent on the relative importance of the demersal and the pelagic fisheries.

The survey results indicate close correlation between species distribution and types of bottom, as well as depth, but no clear relationship with temperature. However, there are possibilities of seasonal movements and spawning of many demersal species, being related to temperature of the water, which shows very high seasonal variaton, particularly in the Gulf.

It is important to remember that the results presented here are only first estimates and based on a number of assumptions, e.g., the efficiency of the trawl. Therefore, the results should be applied with caution. Monitoring surveys should be conducted from time to time and systematic collection of fishing effort and catch statistics should be initiated without further delay for proper assessment of the status of stocks and for introducing effective management measures when needed.

NO: 11194

1227-15

[illegible]